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THE POTENTIALITIES OF PRESENT TECHNOLOGICAL CAPABILITIES
IN THE LATIN AMERICAN COMMODITY SECTOR */

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INTRODUCTION

A rather controversial issue on the evolution of international trade points to the question of whether or not there has been a significant downward trend in commodity prices compared with those of manufactured products, at least since the end of the Second World War. Recent studies (Sapford 1985, Grilli and Yang 1988), though not necessarily agreeing on the extent of such decline, support the proposition originally advanced by Prebisch (1949) and Singer (1950 a) on a secular price deterioration. Latin America and the Caribbean, which rely still heavily on commodity exports as their major source of foreign exchange, have not escaped this fate, the consequences of which are directly reflected in the depressed regional price indices of the post-war period (ECLAC 1986 a) and the worsening in the terms of trade.

The theoretical reasons for believing in the existence of a long-term deterioration in commodity prices from the Third World perspective are well known. They include the low price- and income-elasticities of demand for commodities as compared with manufactures, and the asymmetric impact of labor union power in developed countries and labor force surplus in developing countries on the distribution of benefits of increased productivity. In addition to these conventionally discussed factors, there are a number of structural changes which appear to be gaining an increasing importance in recent years. On the demand side of commodity markets, one may notice: (i) a lessened role of the manufacturing sector and an increasing share of the national income being spent on services; (ii) a shifting pattern of output in the developed market economies (DMECs) away from energy-intensive techniques of production; and (iii) an accelerated rate of technological change and a rapid diffusion of new techniques, new synthetics and new materials, and the displacement of traditional natural materials by these new products. On the supply side, most remarkable have been the acceleration of production in a number of commodities, particularly agricultural, and continuous improvements in productivity, both in developed and developing countries, through applications of new production technologies.^{1/}

The emergence of new technologies casts a strong bearing on the export prospects of developing countries. While the competitive advantage based on

natural resources endowment and surplus labour force in many developing countries may be eroded by these changes, they also offer new production opportunities, if seized in time and properly exploited, which would improve their productive capacity and export performance. Which of the two scenarios is more likely is a question of great importance and policy relevance, particularly for the South.

The scope of "new technologies" is diverse and encompasses a broad range of activities (see UNCTAD 1984 f). New developments most often referred to are microelectronics, biotechnology and materials technology. The use of microelectronics has permeated a great variety of activities, and its main use in the commodity sector has been in agriculture (e.g., irrigation, cattle monitoring and crop control). With microelectronics, production processes have become highly automated,^{2/} and in a majority of cases more capital-intensive, affecting demand and supply, through not only production but also in efficiency gains in stock management and other administrative reorganization procedures.

The so-called information revolution has had a strong impact on the financial aspects of the commodity sector as well. A much higher speed in and lesser costs of information processing have facilitated the portfolio selection among a variety of financial commodities and primary commodities. It also enabled the installation of "program trading". The 24 hour round-the-clock trading system organized for gold, petroleum, bonds, stocks and commodities worldwide has encouraged institutional investors to try to get a margin by revolving their funds in a very short time, resulting in more volatile commodity price movements.

In biotechnology, besides the traditional bio-processes (bread, cheese, beer, wine, etc.), the latest advances in molecular biology, biochemistry, microbiological genetics and biochemical engineering have found a large range of laboratory applications, and some of them on a commercial scale. The greatest impact of biotechnology development should be in agriculture, with plant agriculture alone accounting for more than 60% of the potential market, estimated at US \$50 billion a year (Ahmed 1988). In agriculture, in almost every aspect of economic cultivation, there are tantalizing prospects to enhance yields, renewable resource-based production, and human welfare.

Bio-processing in the areas of synthetic fuels, recovery of materials (e.g., ore recovery in mining) 3/ and others has an ample range of actual and potential applications.

Materials technologies, as in fine ceramics, optical fibres, plastics and composite materials, have enabled improvements in the quality of many existing products, led to reduction in manufacturing costs through saving of energy and materials, weight reduction, increased the scope for manufacturing activities in small- and medium-size markets, and most importantly stimulated the development of new products.4/ These new materials technologies are believed to encourage the displacement of traditional materials (e.g., optical fibres vs. copper in telecommunications, fine ceramics, plastics and composites vs. steel and aluminium in car manufacturing), but they also create a new demand for selected commodities.

As some studies (Pérez 1986, UNCTAD 1986 d) suggest, the socio-economic impact of new technologies should differ depending on the extent to which the technology in question influences the existing "techno-economic" system. Whether it will bring favorable consequences depends on what areas it is applied to --renewable or non-renewable inputs--, as in the contrasting case of agricultural production and mineral extraction. It will also depend on resulting alterations in price and ensuing export earnings.

Allowing for the danger of over-simplification and possible interrelated-ness among them, one may refer to at least three distinct groups of technological development: (i) incremental innovations, entailing small improvements in the existing array of processes and products in different industries; (ii) radical innovations, entailing the development of fundamental new materials such as polyethylene or completely new products, such as optical fibres, fine ceramics, etc.; and (iii) technological revolutions, such as the introduction of steam power, internal combustion engines, electricity, the Bessemer steel production, mass assembly production lines, microelectronics, and possibly superconductivity, which have entailed or are expected to entail profound and far-reaching productive transformations throughout the economy. The present study focuses mainly on the first two categories, which have had a pervasive day-to-day impact so far on primary raw material exports of developing countries, but by no means underestimating the significance of the

third group of technological development for the future prospect of the international commodity sector.^{5/}

This study aims to assess the impact of technological change on commodities, especially on the demand side, in a broad perspective --not indulging much in a detailed analysis of individual products--, in order to draw relevant lessons from past experiences and to identify some policy areas for action, bearing in mind the particular position of the Latin American countries. The general remarks made in Chapter I on structural changes and interrelationships between technological innovation and materials substitution help to depict the nature of the link between technological change and commodity demand and supply. The analysis made in Chapter II of the changing consumption level for commodities of major regional interest in the principal OECD and Latin American countries, on the one hand, supports the general notion of the declining rate of consumption per real GDP of the DMECs, but on the other, points out clearly huge differences in the level of per capita consumption between the DMECs and the Latin American countries. Chapter III provides some comparative cases, --two metals (aluminium and copper) and a group of agricultural raw materials and their synthetic substitutes--, in order to work out recommendations on commodities regarding technological innovation. Finally, in Chapter IV some strategic areas for improvement and co-operation (namely, increasing technological content in exports, re-orientation of trade towards the proper region and intensification of local processing) are analyzed within a comparative framework with the Asian region. This study supports the view that there are still in the region areas not fully exploited under the existing technological capabilities, and that their potentialities could be substantially enlarged by introducing modifications or improvements into prevailing production structure.

I. NATURE AND CHARACTERISTICS OF WORLD TECHNOLOGICAL CHANGE AND ITS IMPACTS ON COMMODITY DEMAND AND SUPPLY

This paper focuses mainly on technological changes affecting the demand for primary commodity exports from developing countries. This way of dealing with the subject leaves out therefore a wide range of changes on the supply side. Such issues as the impact of technological change on production through improved productivity or the creation of new products or production methods are complex in nature and too many in number to be fully documented here; nevertheless some illustrative cases deserve to be mentioned.

1. Technological developments on the supply side of commodities

a) Minerals and metals

In the mining and metal-working sectors, besides the advances in mineral exploration,^{6/} most of the new technologies currently in use have emerged or have been improved during the last decade, as a response to, the first oil price increase in order to save energy, reduce operational costs and improve quality. These innovations, in turn, have had two major effects: on the one hand, making metals more competitive, thereby resisting the loss of segments of their traditional markets threatened by economic recession and the growth of substitutes; and on the other, achieving raw materials savings in the production and manufacturing stages.

Developments in the iron and steel industry are illustrative. The technology involving the processing and beneficiation of iron ore has enabled the industry to lower its costs of producing primary iron from iron ore. These techniques have resulted in an increased production of iron ore as well as sinter and pellets. In turn, their increased use has led to a reduction in the iron ore input required per unit of primary iron output. This is because the extent to which any of these inputs can be employed in primary iron-making is linked to the adoption of a particular iron-making process.^{7/} Due to the improved technology in blast furnaces, and as a result of the more strict market requirements regarding use and quality of ore, the average ratio

between the iron ore feed and the pig iron produced has declined from 1.95 in 1955 to 1.88 in 1975 and to 1.81 in 1985. The rise in the average grade of iron ore worldwide (average Fe content in per cent) has been from 48% in 1955 to 59% in 1985 (UNCTAD 1986 c).

This industry has also witnessed a series of concurrent developments, one of them being the emergence of "new mini-steel works". These plants have the advantage of being able to produce different types of steel, mainly light and long products, and in the future, flat products. These plants may also be enlarged by modular expansion according to market requirements. Also the increasing and expanding use of electric-arc furnaces (accounting for nearly to 25% of world crude steel production in 1985) has reduced the quantity of primary iron needed to produce a unit of crude steel from 0.70 in 1955 to 0.68 in 1985. Another important technological change has been the development and widespread adoption of continuous casting. Its share in world steel production increased from less than 1% in 1960 to approximately 50% in 1985. These are some of the main technological changes which are under way, adversely affecting iron ore demand in recent years through minimization of inputs, while at the same time improving product range and quality.

With regard to other metals, though the available technologies are in a process of continuous evolution, current developments are in the majority of cases modifications of established techniques, rather than entirely new processes. In the case of aluminium, for instance, the two major processing steps, the production of alumina and its smelting to obtain aluminium metal, have been governed by two basic processes developed at the end of the previous century: the Bayer process for the conversion of bauxite into alumina and the Hall-Héroult process for smelting alumina into aluminium. These have remained unchanged in their basic chemistry, except for proprietary modifications made by individual producers. Nevertheless, in more recent years, there have been attempts to by-pass one of the processing stages which may in due course lead to new commercially viable technologies (Brown and McKern 1987).

In copper, the main area of progress has been the development of hydrometallurgical processes. This has been accompanied by several energy-saving methods in mining processes, such as improvements in operational controls by means of computers and on-stream analytical instrumentation,

refinements in equipment used in crushing, grinding and size control. In the semi-finished stages of production of these non-ferrous metals, as well as in the case of iron and steel, the introduction of continuous casting, which reduces capital requirement at the milling stage, has been a major technical development. This innovation is routinely used today. Based on these observations, the main limitations to the adoption of new technologies, at least in the primary processing stage of metals, may arise not so much from the complexity of and accessibility to them, but rather from the need to incur in large capital outlays.

b) Agricultural products

In agriculture, the most remarkable changes centered around "the Green Revolution". This was mainly concentrated in some developing countries of South and Southeast Asia and Latin America, based on the development, diffusion and adoption of modern high yielding varieties, particularly rice, wheat and maize, together with an increased use of inorganic fertilizers and irrigation.

During the last two decades, the majority of Latin American countries witnessed a rapid transformation in this sector with significant changes in their pattern of production and productivity. Various studies (a summary is provided in IDB 1986) on the region's agriculture support the view that the use of non-traditional inputs and technological changes have played a much more important role in the sector than the contribution of other factors such as an increase in acreage and manpower. Available estimates indicate that the contribution of land and labor to product growth was in the 15% range in the 1970s, while it ranged between 17 and 30% in the 1960s. On the contrary, the contribution of non-traditional inputs, such as chemical (fertilizers and pesticides) and mechanical and physical (machinery, equipment, physical works) innovations, was responsible for most of the product growth in the 1960s and for about 40% of it in the 1970s. Together with other biological (new seed varieties) and agronomical (production systems, sowing times, etc.) factors, technological innovations accounted for more than 40% of product growth.^{8/}

Now the Green Revolution seems to have run its course, and the yield-enhancing potentials of mechanical and chemical inputs may be largely exhausted. Coupled with fears of not being able to sustain a high growth rate

in agriculture and continued population growth, lagging productivity has led to increasingly focus attention on seeking support for agricultural research on biotechnology, hoping to attain an upsurge in productivity gains, in both developed and developing countries.

As pointed out by certain authors (Buttel et. al. 1985, Ahmed 1988), a feature of Biorevolution, which differentiates it sharply from the Green Revolution, is its predominantly private character. Major actors in biotechnology are transnational corporations which have managed to put together their in-house research capabilities, equity interests in genetic engineering ventures, seed company ownership and access to university research via funding arrangements.^{9/} The Green Revolution was, on the other hand, conceived and implemented within an institutional structure consisting mainly of public and quasi-public organizations, where the governments of developing countries and their national breeding programs participated as clients. In view of this difference in character, it is likely that developing countries will become increasingly dependent on technologies owned by companies located in the North, and that the bulk of technological transfer in biotechnology will be made under the aegis of private capital with lesser transparency, which introduces the problem of patents and proprietary information.

Even though the routine cultivation of biotechnologically transformed plants is not expected before the mid-1990s, it is now the time to evaluate its possible socio-economic impacts, in order to apply appropriate measures before structural rigidities are firmly established. The new Biorevolution should be taken advantage of and be directed properly because it embodies not only some unfavorable elements such as a possible displacement of labor force and a more "closed" scientific environment, but also positive potentials for the poor of the Third World. They include a reduction in the dependence on agrochemical inputs, leading to substantial cost reductions, general gains in productivity and a wider variety of food products well matched to local conditions and tastes, and a shorter time lag in the adoption of biotechnology by small farmers than in the case of the Green Revolution.

2. Structural changes influencing commodity consumption patterns

a) Sectoral changes

It is asserted by some sources (for instance, UNCTAD 1986 b; González-Vigil 1985) that for a broad range of raw materials exported by developing countries, the growth of demand in the DMECs is either stagnant or falling. Although the less-than satisfactory economic performance of the North and South in the present decade has been an important factor for a sluggish demand, it does not fully explain the decline in per capita consumption or the intensity of materials use --that is, in the amount of raw materials consumed per unit of real GDP (this concept is elaborated in Chapter II of this study). In the 1960s, for instance, when GDP of the DMECs grew at 4.3% annually, consumption of many commodities, in particular minerals and metals, increased faster than GDP. In contrast, in the following decade, while the average economic growth rate of these countries dropped to about one-half of that recorded in the 1960s, consumption growth rate fell even more sharply. During the 1970s many commodities even recorded negative growth rates. It should also be recognized that the severely depressed commodity prices in the 1980s have not led to a market recovery of demand, a fact which evidences in part a dis-linking process of the commodity demand away from the world economic fundamentals. Furthermore, IMF has recently pointed out that "the decline in the intensity in the use of metals seems to have accelerated in the early 1980s. This acceleration appears to have been encouraged by the record high prices for copper, iron ore, and tin 1979-1980, which resulted in the more rapid development and adaptation of material saving technologies and the substitution of other materials for metals" (IMF 1985, p. 134).

Deep in the process of structural transformation in commodity demand, there are said to be at least three factors at work: (i) the general shift of GDP towards services which commonly entails a lower material intensity than manufactures; (ii) the on-going "de-materialization" of production processes which consists of a shift in the composition of demand away from the products of the more intensely raw material-consuming industrial activities; and (iii) a reduction in or an eventual elimination of the amount of raw materials consumed in the manufacture of existing or newly emerging products through

substitution of another material in those products, and through more intensive or more economical use of the material, material saving or economization. Reductions in the intensity of use in traditional metals by the DMECs examined in chapter II are believed to be a function of these factors, principally (ii) and (iii).

Undoubtedly, the engine of growth of the 1960s was the manufacturing sector. In that decade, the annual growth rate of the sector exceeded that of GDP —5.8% against 4.3%—, while in the following decades, the reverse was the case, with the former growing at 1.7% against 2.7% of the latter. Within the growing service sectors, certain areas, particularly finance, insurance, business and personal services, have increased their importance, whereas other areas such as construction, wholesale and retail trade, restaurants and hotels, transport and communications have maintained or reduced their share (UNCTAD 1986 b). The increased service-sector orientation of industrial economies is believed to be, at least partially, responsible for the declining trend in demand.^{10/}

As a reflection on this same issue, Duncan (1988) points out that the share of services in the GNP of DMECs has been increasing for some time, reaching a high percentage in some of them before 1973. He explains that the relationship between industrial production and GNP is non-linear, and that an industrial economy grows rapidly —above a GNP growth rate of 2-2.5%— when its manufacturing sector is booming, and conversely, at low GDP growth rates services grow more quickly.

The change in GDP patterns has been accompanied by marked changes within the manufacturing sector. An examination of the growth of domestic demand in volume terms by industries in selected DMECs for the period of 1972-1982, as shown in Table 1, confirms those sectoral changes. Strong-demand industries include electrical equipment, electronics, information technology, automated office equipment, precision instruments, chemicals and pharmaceuticals. Demand for this group of products grew on average by 6.7% during the period. Moderate-demand industries, instead such as rubber, plastics and transport equipment, instead had a growth rate of 2.5%, and weak-demand industries, such as textiles and metal products, grew by 1.1%. This observation endorses the

generally accepted view that at least for the DMECs, growth has been poor in raw material-intensive industries.

At a further disaggregated level, within the engineering industry of the DMECs (see Table 2), it becomes clear that growth has been poor or even negative in metal-intensive industries, such as ISIC (International Standard Industrial Classification) 381 (metal products, except machinery and equipment), which is the least sophisticated sector of all engineering fields; electrical-generating equipment; transformers and switchgears; electric motors of all descriptions; and shipbuilding. In contrast, a high level of performance has been found in high technology industries with a low metal to value-added ratio, i.e., non-electrical(382) and electrical machinery(383), in particular industrial robots and computers for factory automation, consumer electronics and telecommunications, semi-conductors and integrated circuits.

Meantime, developing countries as a whole have fared substantially better in those industrial areas where the DMECs have seemingly been losing their comparative advantage. A comparison of the estimated percentage changes in value-added for the 28 branches of industries under ISIC for the 1976-1985 and 1985-1988 periods, discloses that the raw material-intensive industries, such as food, beverages, wearing apparel, wood and wood products, paper and paper products, rubber products, iron and steel, and non-ferrous metals, have shown relatively high growth rates for the Third World as a whole. These rates, in most cases, are significantly higher than those corresponding to countries in the North (UNIDO 1987 p.8). This phenomenon certainly reflects the changing structure of international trade and production, and the structural adjustment processes under way mainly in the DMECs.

The intra-sectoral transformation in the manufacturing sector is intricately related to the sustained progress made in information technologies and automation. Advances in these areas have led to: (i) a tremendous increase in the continuity and integration of the reduction and distribution processes, by means of the unification in a simplified command unit of the previous separate functions of conception-design, production and marketing; (ii) bigger and yet more flexible scales of production, supported by more diversified lines of products; and (iii) considerable savings in factors of production, including labor, energy costs, as well as in the volume and value of raw

Table 1

GROWTH OF DOMESTIC DEMAND IN VOLUME TERMS BY INDUSTRIES IN SELECTED EEC
COUNTRIES, THE UNITED STATES AND JAPAN, 1972-1982
(Per cent)

Industry	EEC ^{a/}	United States	Japan	EEC ^{a/} United States and Japan
Strong-demand industries	5.2	4.8	13.5	6.7
Electrical equipment and electronics	3.7	5.5	15.1	7.7
Information technology, automated office equipment and precision instruments	8.9	5.7	6.8	7.0
Chemicals and pharmaceuticals	5.5	3.7	11.8	6.4
Moderate-demand industries	1.0	2.3	4.8	2.5
Rubber and plastics	3.2	5.0	1.2	3.5
Transport equipment	3.2	1.4	7.1	2.9
Paper pulp, packaging and printing	1.8	2.9	3.7	2.6
Food, drink and tobacco	2.0	1.7	3.8	2.2
Industrial machinery	0.2	3.2	3.6	2.0
Weak-demand industries	0.2	0.5	3.0	1.1
Miscellaneous products	1.3	1.8	1.4	1.5
Textiles, leather and clothing	0.2	1.5	2.7	1.2
Steel and metal ores	0.7	-0.7	3.7	1.3
Metal goods	-0.5	0.0	4.2	1.2
Construction materials, non-metallic minerals	0.9	0.3	1.8	1.0
Total manufactured products	1.9	2.3	6.4	3.1

Sources: Eurostatistics and Commission departments. Cited in UNIDO (1987).

Note: Based on United States dollars and at 1975 prices and exchange rates. The average annual growth rate is calculated on the basis of data smoothed over two years: average for 1981-1982 compared with average for 1972-1973.

^{a/} Belgium, Denmark, France, Germany, Federal Republic of, Italy, Netherlands and United Kingdom.

Table 2

TREND GROWTH RATES OF PRODUCTION OF ENGINEERING INDUSTRY a/
SECTORS IN THE MAJOR COMMODITY IMPORTING DMECs 1976-1985
(Per cent)

Sectors	USA	Japan	Federal Republic of Germany	France	UK	Italy
Metal products, except machinery & equipment (ISIC 381)	1.7	1.6	0.9	-0.1	-0.9 <u>b/</u>	—
Non-electrical machinery (ISIC 382)	3.6	8.1	2.6	0.5	-0.3 <u>b/</u>	3.0
Electrical machinery (ISIC 383)	5.2	14.1	3.4	3.0	1.6 <u>b/</u>	2.9
Transport equipment (ISIC 384)	3.2	3.5	3.9	-1.1	-2.4 <u>b/</u>	2.8
Precision instruments (ISIC 385)	2.0	14.8	1.4	2.6	1.6 <u>b/</u>	0.1

Source: United Nations, Industrial Statistical Yearbook, (various issues).

a/ ISIC Division 38 (Manufacture of Fabricated Metal Products, Machinery and Equipment).

b/ 1978-1985.

materials, per unit of output (González-Vigil 1985). These new elements taken together imply a lesser growth of productive "heaviness". Furthermore, the general tendency towards higher automated and continuous production processes increases the demand for most metals classified within the high-technology and special steels and alloys categories, due to their high strength/low weight alloys and superalloys, for using them in high-speed/hot-work special tools and machinery, or in special corrosion-inhibiting applications.^{11/}

An illustrative case of the unimpressive recent demand for major traditional non-ferrous metals of general uses, compared to that of high-tech metals, is the United States domestic consumption pattern of twelve metals between 1972 and 1982. Only four of them exhibited a positive consumption growth: aluminium, the platinum-group metals (includes iridium, palladium and platinum only), titanium, and tungsten. Consumption of the remaining eight metals decreased at average annual rates varying from 1% (copper) to 5% (manganese, tin, and zinc). Two of the four metals with growth in consumption derived their growth primarily from single markets: aluminium for metal cans, and platinum for catalytic converters. Only titanium and tungsten experienced increased consumption in a variety of end-uses during this period (United States Bureau of Mines 1986 a). The same data also confirm that total consumption and consumption per unit of output decreased for all metals except titanium, tungsten and the platinum-group metals.

It is noteworthy that Latin America's share in world reserves of new and other minerals such as chromite, cobalt, tantalum, vanadium, tungsten, zirconium and platinum metals is negligible, and that only molybdenum (26%), columbium (78%) and silver (29%) accounted in 1985-1986 for a substantial world reserve share (Kürsten et. al. 1988). In this sense, a strategy based on the exploitation of these non-traditional materials and the exercising of bargaining power possibly arising from concentrated supplies is not likely to be a viable development route for the region.

In sum, the older non-ferrous metals have been affected to a greater extent and this category of metals have also been the most affected by substitutions among metals, in favor of light and specialty metals. Important substitutions among metals in favor of the older ones have been less frequent, as light and specialty metals usually find metal substitutes within their own category.

b) Material substitution

As the substitution process in commodities entails a number of different types of phenomena, it is worthwhile to elaborate on the concept. As Tilton (1983) points out, the most obvious case is material-for-material substitution, where one material is used in place of another. Examples are abundant and they include the use of aluminium beer cans for glass bottles, the installation of plastic instead of copper pipes, and using aluminium rather than copper-brass radiators to cool automobile engines.^{12/} In agricultural products, the most striking post-war development was the marked expansion of man-made synthetic fibres which replaced natural fibres. Sugar has faced severe competition from High Fructose Corn Syrup (HFCS) and high-intensity sweeteners such as aspartame and saccharin. In this type of substitution, though the competing materials provide essentially the same function, the selection is made on the basis of cost-effectiveness, efficiency or specific properties.

Another important category is others-for-material substitution, where consumption is reduced (increased) by augmenting (reducing) non-material inputs such as labor, capital and energy. A clear case is the hand soldering of household electronic products which requires less solder than more automated production using printed circuit boards. Producers of these products, however, have favored the latter despite their higher material intensity because they lower labor costs.

The next type is called inter-product substitution, where a change in the composition of goods to meet a specific need alters the demand for materials. Examples include television vs. movie theaters, public transportation vs. private cars, telephones vs. letters, satellites vs. underground cables for long distance communication. In this type, there is no alteration in the manufacturing process or the materials used in production, but there are alterations in material use through changes in the mix of goods and services provided.

Last, but not least, comes technological substitution, where a technological innovation allows a product to be made with less material, perhaps adding new properties to it or improving the existing ones. This series of substitutions thus entails material-saving effects, as mentioned

earlier, and quality alterations. The upward shifts in energy costs in the 1970s and a greater concern over the environment, for instance, have led to an active search for cost reductions and economization of materials. This thrust resulted in renewed efforts in scrap and waste recoveries, and more efficient processing and refining methods, which gave rise to superior combinations of strength, resistance to oxidation, ductibility, formability, longevity, rejection-rate reduction, etc. In the United States, thinwall casting, coupled with the downsizing of automobiles, has brought the weight of zinc diecastings used in American-manufactured cars down from 51 lbs in 1975 to 23 lbs per vehicle in 1983 (United States Bureau of Mines 1986 a). Technological innovations in the zinc diecasting industry leading to thinwall casting allowed zinc to gain an increasing share of the metal casting market, but at the same time, brought about a much more efficient use of the metal resulting in less zinc used in the process. Other examples, among many, include the ability of aluminium to yield 7 000 more beverage cans from a ton of metal than a decade ago, and the reduction in the tin content of the average size tinplate beverage container by 93% between 1950 and 1977.

The foregoing brief differentiation in material substitution highlights its complex nature and suggests a possibility of manifold interactions among various factors. In addition to the well-known material-for-material substitution, it may result from the introduction of new technology, from changes in relative factor-input prices, or from shifts in the composition or quality of final goods.

Material substitution proceeds faster in some commodities than in others. The substitution process has made substantial, if not almost complete, inroads in the cases of cellulosic and synthetic fibres (mostly polyester) at the expense of cotton and wool in the apparel market; polypropylene and polyethylene in place of jute and sisal in these commodities' main markets, particularly in packaging; natural rubber replaced by synthetic rubber in the tire and other markets; synthetic detergents for lauric oils in their major inedible end uses; and aluminium for tin in some segments of the beverage can market. In the majority of these products, as discussed later, there has been some market recovery, thanks to the producers' efforts to promote the intrinsic properties of the products over their substitutes. Regarding other

commodities, substitution is at an incipient stage. In these cases, past trends are not a good prospective. Sugar, copper, steel, aluminium and other metals are among the major commodities where substitution is taking place and is expected to increase in the future.

3. Technological innovation and its relation to material substitution: some conceptual considerations 13/

The behavior of commodity markets tends to raise doubts over the presumption of the neoclassical thinking that the functional relationship between price and demand is automatically reversible. In these markets, if a material loses a particular market, even temporarily, that market might be lost forever. It may be quite plausible that an industry may not recapture a market lost during a price rise even if its price subsequently returns to a previously low level. The assessment of this reversibility becomes much more questionable for the medium- or long-term during which the demand for plant and equipment as well as technology can change significantly.^{14/} Even in the short-run, where the cost of a particular material input does not loom high in the production cost of many finished products, changes in material prices alone do not usually produce major shifts in the output of final goods or services. It is more likely in the short-run that relative price changes affect the degree of utilization of secondary markets (scraps) when this option exists. In the case of the United States, the share from scraps accounted in 1986 for 25% and 45% of the primary production of aluminium and copper, respectively. Depending on production costs/prices of primary and secondary origins, producers change from one procurement source to the other or mix both of them. Faced with the threat of impending substitution, producers might also decide to keep prices below what the market will bear in order to prevent it, or they might consider price discrimination in favor of clients with the greatest substitution possibilities.

The demand curve of a material is generally assumed to be continuous and smooth. However, given the nature of material substitution this assumption may not be very realistic, particularly for those materials which do not have diversified uses in their applications. Prices may rise within certain limits, with little effect on demand, but once a particular threshold is

exceeded, demand may fall dramatically making the use of a competing substitute more attractive. Such discrete jumps may be found in the short- and medium-term demand curves, and they might be much more pronounced in the long-run where technological innovation, by its own nature, exerts its influence in a highly unpredictable manner. Where the main effect of price changes on material demand occurs through indirect technological change, there does not necessarily exist the inter-temporal price stability generally assumed. Innovations inherently involve a certain random or chance element, and there is not a stable relationship between prices and the number of induced innovations, or between the number of induced innovations and their cumulative effect on demand.

As implied earlier, changes in relative prices of competing materials alone trigger few immediate shifts in demand. It is more likely that not only material costs but also those of other factor inputs, specific properties of materials, performance and quality considerations, etc. are taken into account. In other words, the only relevant cost in material substitution today is the so-called "total package cost".^{15/} Many new materials are priced higher than the conventional ones they displace. However, these new materials may be preferred because they offer the opportunity to reduce manufacturing costs enough to offset their higher prices (Fraser et.al. 1987).

It is worth noting that the threat of substitution has important implications for market power. The market power of an individual firm is usually assessed by the industrial concentration or market share of the industry in question. A quick look at the concentration ratio, for instance, in the mineral and metal sector and other primary material fields, might lead to the conclusion that firms operating in the concentrated industry possess market power and obtain excess profits. The threat of possible substitution for another material coming from other industrial sectors, however, could severely restrain this power, even in highly concentrated industries. The collective or collusive efforts by established firms to maintain artificially high prices might foster a series of technological innovations by other producers in other industrial fields. In this sense, while high prices might have little effect on substitution in the short-run, the consequences for the longer-run could be adverse, making it irreversible to recapture markets. This

kind of inter-industry competition, as Schumpeter (1950) puts it, "acts not only when in being but also when it is merely an ever-present threat. It disciplines before it attacks." The comparative industrial cases in Chapter III should be regarded in this analytical context.

In short, demand for a material is influenced by its relative price, costs in manufacturing, installation and maintenance, and other factor prices. Intrinsic properties --weight, corrosion resistance, durability, conductivity, visual appearance, manipulative easiness, etc.-- are also extremely important. As discussed in Chapter II, these factors work in conjunction with other demand/supply elements such as domestic natural resource endowment, government industrial promotion programs, cultural and traditional factors as well as the country's per capita income level.

4. Effects on comparative advantages and the international division of labor

The preceding examination gives the impression that the demand prospects for commodities in which the countries of the Third World have been credited to hold a clear comparative advantage, is uncertain, and that the said advantage seems to have been badly eroded by the emerging restructuring of commodity demand propelled by new technologies. Moreover, presumably highly labor-intensive sectors, such as textiles, clothing and electronics assembly, are slowly increasing their capital-intensity, thanks to the incorporation of a higher technology content in production processes (ECTAC, 1988 b).^{16/}

The consequences of the energy and material-saving efforts in the developed world are manifold. Since basic processing activities are energy-intensive and there is a limit to the wastage and recycling capacity, a natural sequence of events has been the relocation of production sites for traditional industrial materials to developing regions. Its chief aim is to benefit from lower raw material and energy costs, savings in the transport costs of raw materials, and flexibility inherent in geographical proximity to raw material production sites. In spite of diminishing material intensity, access to cheaper supplies provides a competitive edge in corporate earnings as long as material inputs are required.^{17/} The cost of iron ore supplied to the new Brazilian steel complex is less than one fifth the price of imported

ore used by Japanese steel mills. The cost of Electric power supplied to aluminium industries located in Brazil, Ghana and Venezuela is only a fraction of that for developed countries. In addition, many agro-industries enjoy cost advantages in terms of the enormous differentials in world prices of agricultural products. It should be further noted that Latin America has been able to transform in a substantial manner its commodity export basket in the present decade, with an accelerated introduction of non-traditional products such as oilseeds and vegetable oils, fruits and fruits juices, crustaceans and mollusks, fish and its products, wood and pulp, and poultry, whose production is basically resource- and labor-intensive.

Another consequence might run in a different direction: specialization of developing countries in the production of certain groups or components which are at the lower end of the quality or fashion scale, which are simpler and relatively less expensive and more labor-intensive. Developing countries will probably continue to identify and tap trade and production opportunities in such products. In the case of steel, for instance, a particular kind of division of labor has developed in the last decades where most developing countries are producing ordinary steels, and some industrialized or NIEs are competing among themselves for the special steels market. While exports of footwear from developing countries will continue to be most successful in high-volume, low-cost markets, producers of developed and a few developing countries compete fully in the fashion market. The new textile machinery introduced in developed countries allows enterprises flexibility in production, higher quality, more emphasis on styling and design and a shift from mass production of fabrics, common in developing countries, to shorter runs of high quality fabrics. Types of finer yarns and lightweight fabrics increasingly sought for in the apparel trade are produced by highly automated textile plants. However, the effects of changes in these technologies need not necessarily be labor-reducing but labor-absorbing.

In support for the preceding implications, the following observations by Duncan (1988) are extremely useful: (i) the Third World share of world production/exports of raw materials has increased for almost all products and is projected to continue increasing in the future; and (ii) the shift of production/exports to the Third World has been accompanied by the increase in

the latter's share in processing. In short, the production /exports of these products have moved and will continue to shift in favor of developing countries partly offsetting the declining growth trend at the global level. This shift has been facilitated not only by large fluctuations in energy prices and environmental concerns like the pollution from processing industries, but also, as shown below, by different stages of economic development.

II. THE USE-INTENSITY HYPOTHESIS: ITS USEFULNESS AND PERSUASIVENESS FOR THE THIRD WORLD

A view gaining certain acceptance recently is that raw materials demand in the DMECs has been slowing down considerably and that the factors responsible for this will soon begin to affect developing countries demand in such a magnitude that the global materials consumption and thereby the future prospects of primary-producing countries will be severely constrained. This chapter will assess the validity of this line of argument analyzing the intensity of use for principal export products of Latin America.

1. Its concept and implications

The concept of the intensity of use is generally defined as consumption of the relevant product per unit of economic activity, in constant prices, with an aim of isolating the impact on demand of factors other than the size and growth of the national macro-economy. It is typically expressed in tons (or kilos) of metal consumed or demanded per million constant United States dollars of GDP. This concept was first employed by the International Iron and Steel Institute for steel demand determination (IISI, 1974), and was applied later on both to steel and non-ferrous metals by Malenbaum (1978) in order to project future demand for these products. Major conclusions of these studies were that the intensity of use is closely correlated with the level of economic development, as measured for instance by GDP/capita, and that the intensity rises up to a certain threshold and then starts to fall as the economy matures.

The reason for the inverted U-shaped relationship between the intensity of use and the level of economic development is straightforward: the initial stages of economic development are characterized by low materials use, especially metal consumption, because of an unmechanized and self-supportive agrarian economy. During the stages of infrastructure building, metal consumption usually grows faster than the aggregate economic indicators, stimulated by the expansion of public and industrial construction and by the development of manufacturing and metalworking sectors. As an economy matures, however, markets for industrial products reach a certain degree of saturation,

and technologically more sophisticated industries and services come to represent a more rapidly growing share of GDP than the traditional metal-intensive activities.

From the above rationales, it is possible to draw some interesting cross-country and time-series implications. These observations have direct bearing with the analysis made in Chapter I. As a cross-country observation, the consumption behavior of metals can be portrayed as an inverted bell-shaped curve, showing the level of use-intensity in relation to GDP/capita, at a particular point in time, say in 1960. The curve thus depicts the evolving structure of economies at different levels of economic development, and variations in use-intensity are attributed to factors, which some (Radetzki 1987) might phrase as shifts in "product composition of income".

Another cross-country observation may be made at a later moment in time (say in 1988), resulting in a downward shift of the curve. The decline in the use-intensity, in relation to the above period, derives from the secular technological progress which makes possible the production of a given set of outputs with ever-decreasing material inputs. This effect, termed as a decrease in intensity to the shifts in the "material composition of products", might permit late-comers to economic development to leapfrog the material-intensive stages of the pioneers and to adopt the most up-dated materials-saving technology. When preparing a trajectory for an individual country during that time span, it is therefore necessary to take into account the combined effect arising from increasing GDP/capita over time and from time-related technological progress.^{18/} The combined outcome of shifts in the product composition of income and the material composition of products, will still be an inverted-U shaped curve but its peak intensity will be lower than at a lower income level.

In brief, the hypothesis argues that: (i) the use-intensity at a given level of economic development will be lower in countries which are late-comers; and (ii) the intensity of use at a given point of time will be higher for middle-income countries than for low-income ones, whose intensity will rise over time up to a certain threshold. This implies, on the one hand, that even though many developing countries may continue to increase their share in the world output or trade of capital and consumer durables, their

future materials demand and use-intensity would not necessarily reach the previous levels achieved by the DMECs at comparable income levels. But on the other, it implies that developing regions, with a substantially lower level of per capita consumption, should be regarded as untapped markets for many commodities for some time to come, pointing to the importance of domestic, intra-and inter-regional market expansion in the Third World.

2. The intensity of use for OECD and some Latin American countries

a) Petroleum and metals

In order to assess the applicability of the above concept to recent developments, this section examines the use-intensity of those OECD and Latin American countries for which data are available. It is expressed in tons/kilos per million 1980 dollar GDP.^{19/}

In respect of petroleum, (Figure 1 a), it seems certain that use-intensity as well as per capita consumption have fallen drastically for all the seven OECD countries examined during the 1970-1985 period. The reduction in intensity was in the 40-50% range. Despite different intensities among them, the reduction process has markedly increased since the second oil-crisis of 1979 in all of them as a result of strong energy-saving efforts. This took place in spite of stable internal energy-pricing regimes in some countries. Among them, the Federal Republic of Germany has shown the lowest intensity as well as the lowest per capita consumption throughout that period. As for the seven Latin American countries examined (Figure 1, b and c), trends are more stable or even increasing --with little adjustment after the 1979 oil crisis-- as in the cases of Mexico and Peru. Venezuela has shown by far a higher intensity and per capita consumption than all the OECD and Latin American countries. The intensity of the latter is generally higher than that of the OECD countries and in some cases is going up, thus in accordance to the hypothetical pattern. It is, however, also true that the intensity depends very heavily on the natural endowment of the product in individual countries. The per capita consumption level in Latin America is appreciably lower than that in the DMECs, in many cases not even amounting to 50% of that in the latter (Figure 2 a, b and c).

The case of steel is similar to that of petroleum (Figure 3 a b). In the OECD countries, there is a clear and rather persistent tendency towards a lower use-intensity. In spite of varying levels, reduction is taking place roughly at a same pace among these countries. Japan, with the highest intensity, reduced its level from 114.5 tons/million 1980 \$ GDP in 1973 to 55.7 tons in 1984. The country with the lowest intensity, France, also reduced it in a consistent manner from 55.9 tons in 1962 to 22.1 tons in 1984, never having reached a level comparable to the other OECD countries. The Latin American countries, on the other hand, show a much wider variation among themselves both on a cross-country and on a time-series basis. Year-to-year movements are so erratic that one country's intensity might change by more than 30% from one year to next. Nevertheless, Brazil and Argentina, together with Chile, are already showing a slowdown trend in use-intensity.

According to the figures of the International Iron and Steel Institute, the levels of apparent per capita steel consumption in Latin America, in relation to the world leaders are extremely low: in 1985 the world's highest per capita consumptions of 709 Kg in Czechoslovakia, 606 Kg in Japan and 574 Kg in the Soviet Union, were far above the region's highest Venezuela 177 Kg, Mexico 113 Kg, Brazil 88 Kg, Argentina 72 Kg, Chile 47 Kg, Colombia 38 Kg and Peru 27 Kg (ILFAFA 1988). Per capita consumption in developing countries generally remains at 10 to 20 Kg, rather than at the 100-200 Kg range of the NIEs. This huge gap in consumption between developed and developing countries suggests that there still remains an extremely high potential for expanding production in the latter. The rapid structural adjustment process of this industry in the OECD countries 20/ should also concur in this direction.

The lopsided steel consumption pattern between the developed and developing worlds leads to a situation where from the roughly 700 million tons of steel consumed internationally, only 6% of them are used in the Third World. Taking the 400 Kg per capita consumption of the developed countries with a per capita income above US\$5 000 as the "ideal" level, Llorens (1988) calculates for the developing world a deficit of 1.300 millions tons. This in turn requires substantial capital outlays for expanding production just to keep in pace with a 2% population increase.

Figure 1 a

Petroleum Consumption: DMEC Countries Per Dollar of Real GDP(1980 \$)

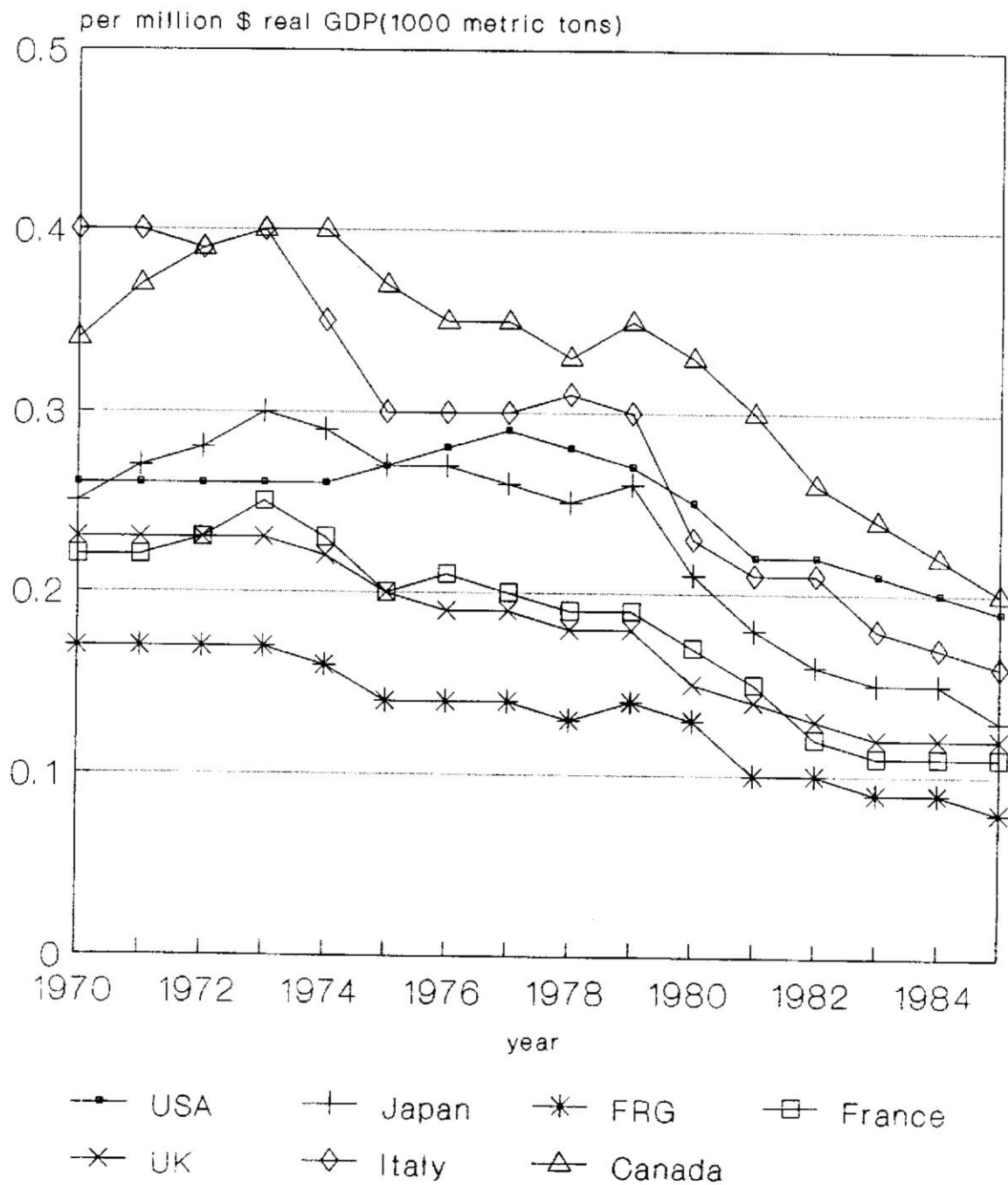


Figure 1 b

Petroleum Consumption: Latin America

Per Dollar of Real GDP (1980 \$)

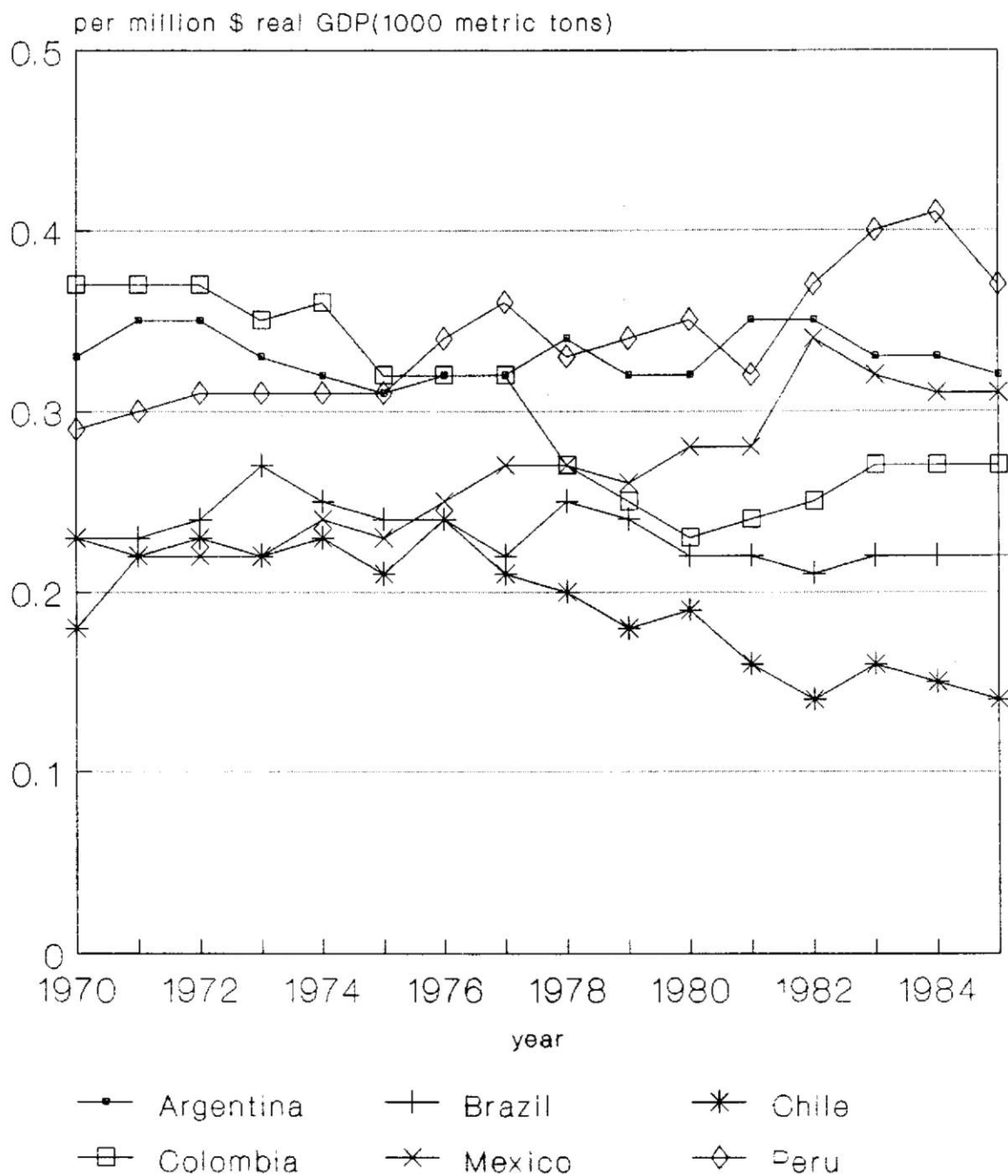


Figure 1 c

Petroleum:Venezuela

Per Dollar of Real GDP (1980 \$)

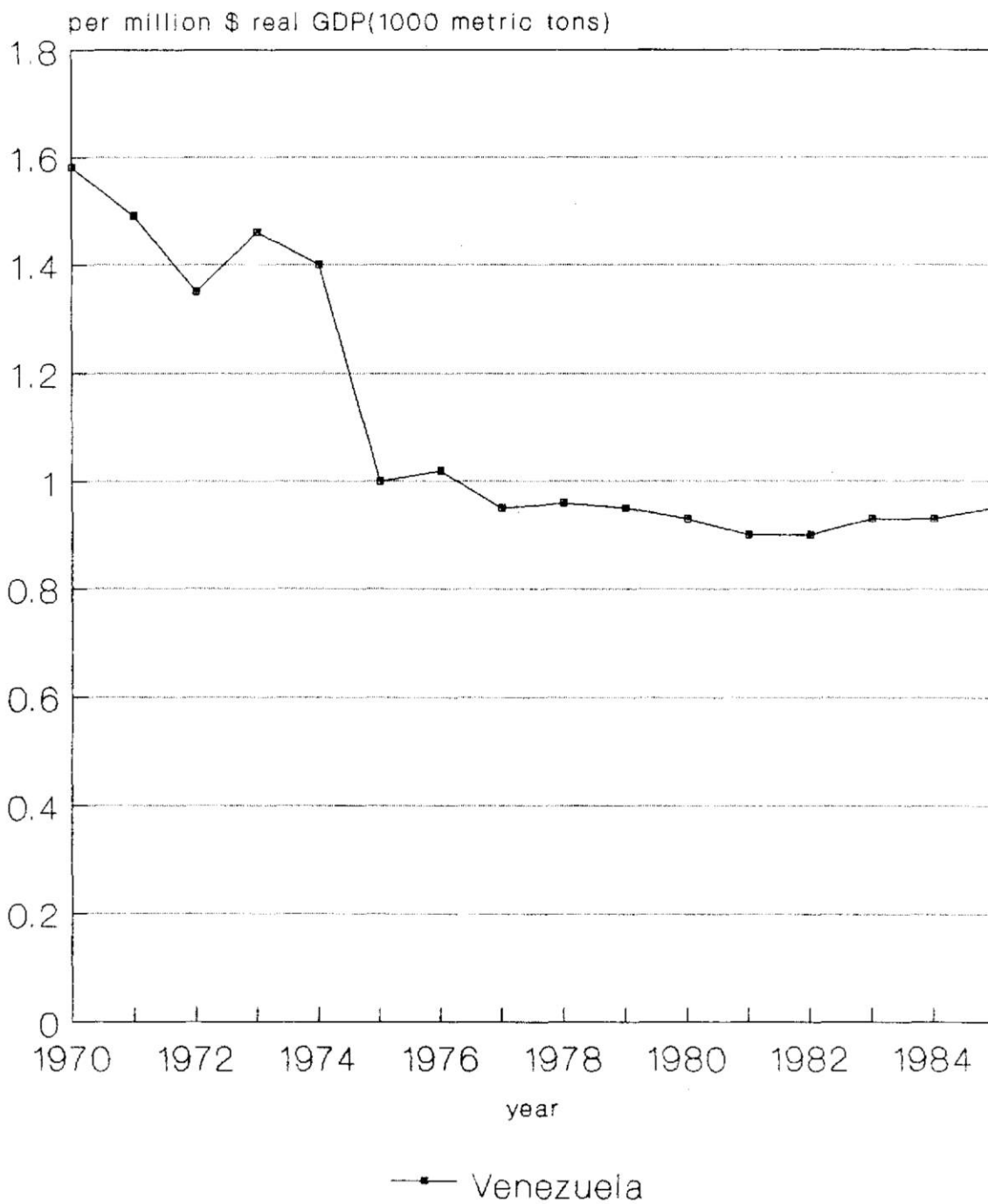


Figure 2 a

Petroleum consumption:DMEC Countries Per capita

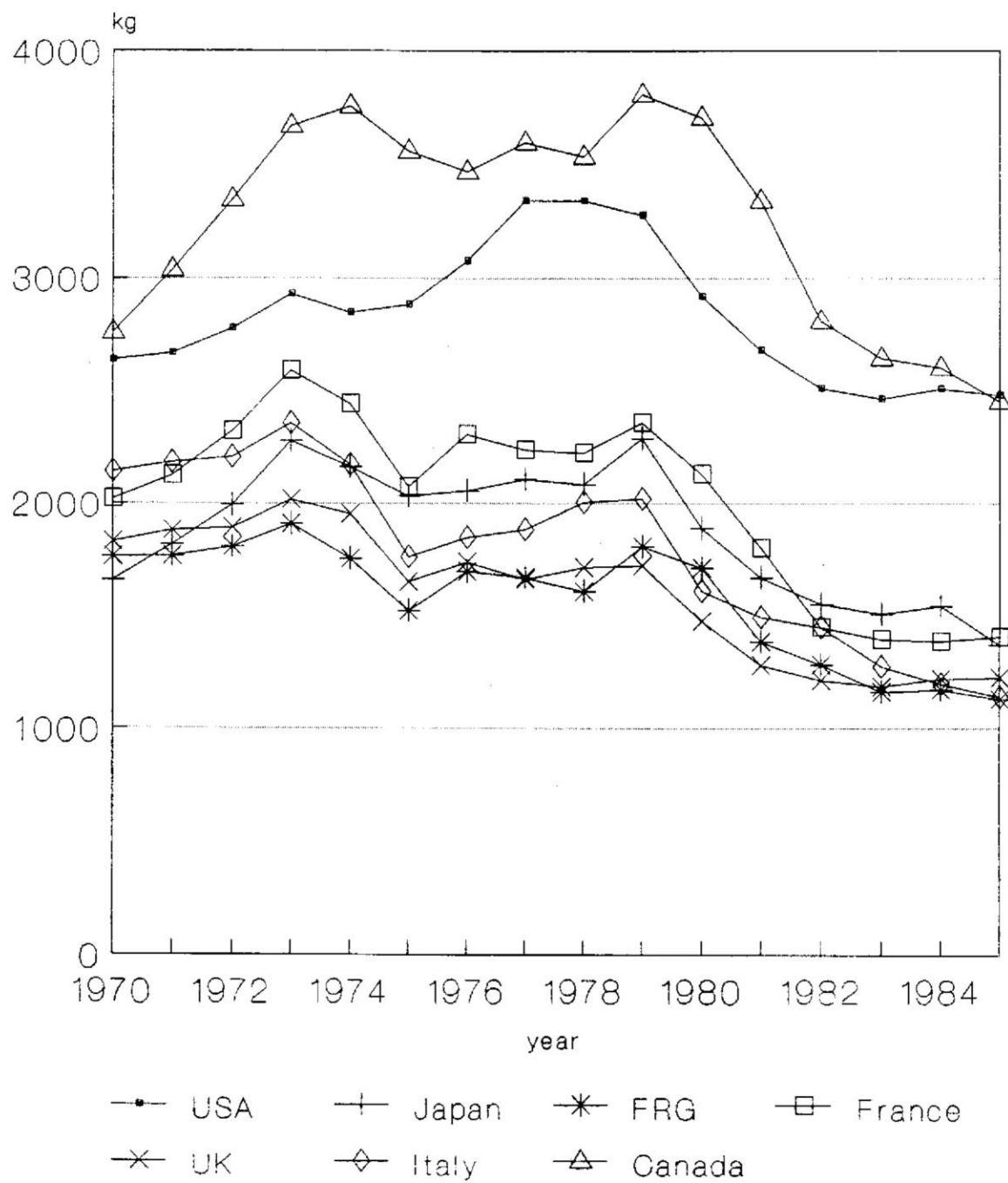
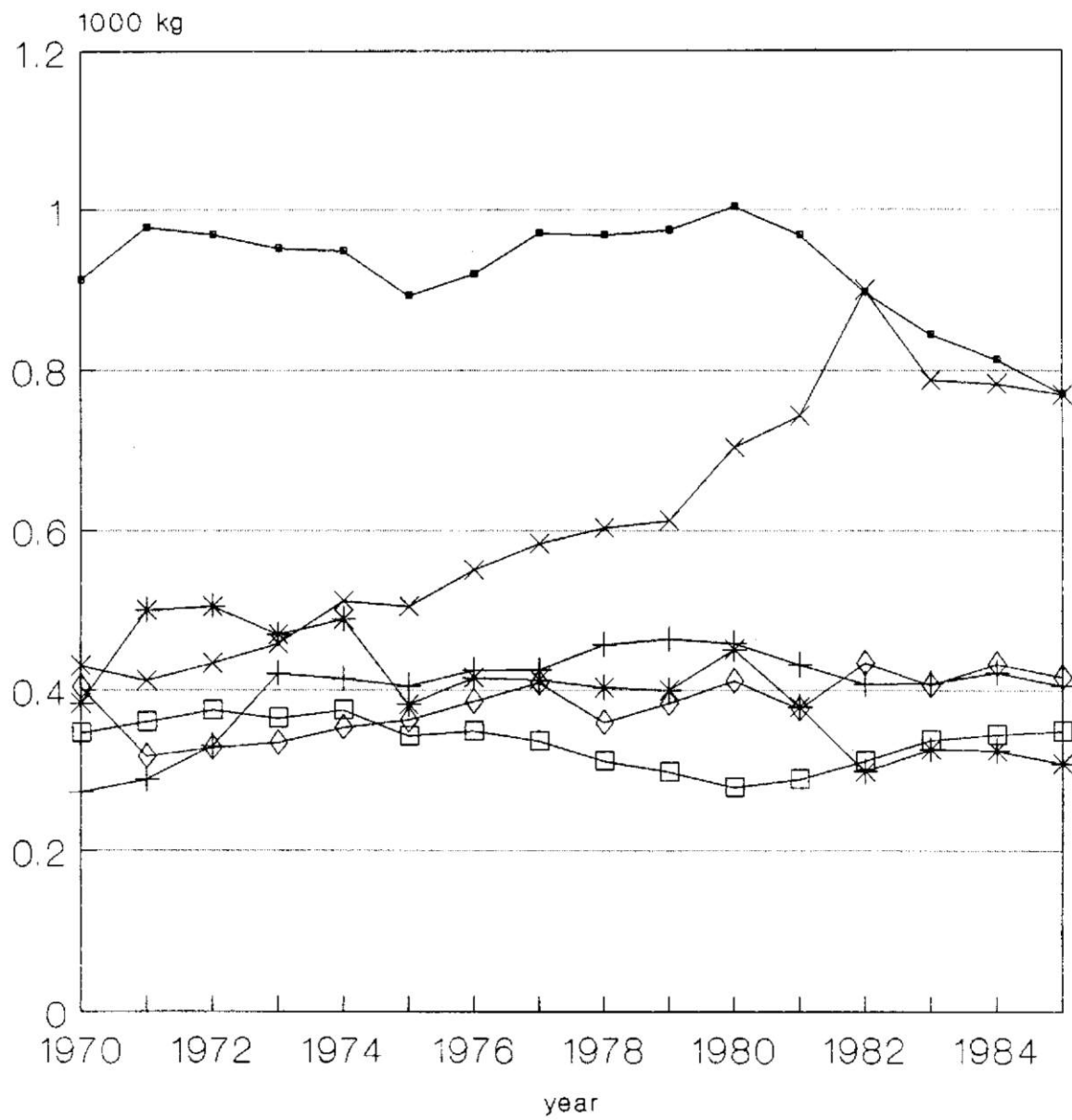


Figure 2 b

Petroleum consumption: Latin America Per capita



—●— Argentina

—+— Brazil

—*— Chile

—□— Colombia

—x— Mexico

—◇— Peru

Figure 2 c

Petroleum consumption:Venezuela

Per capita



FIGURE 3a
STEEL

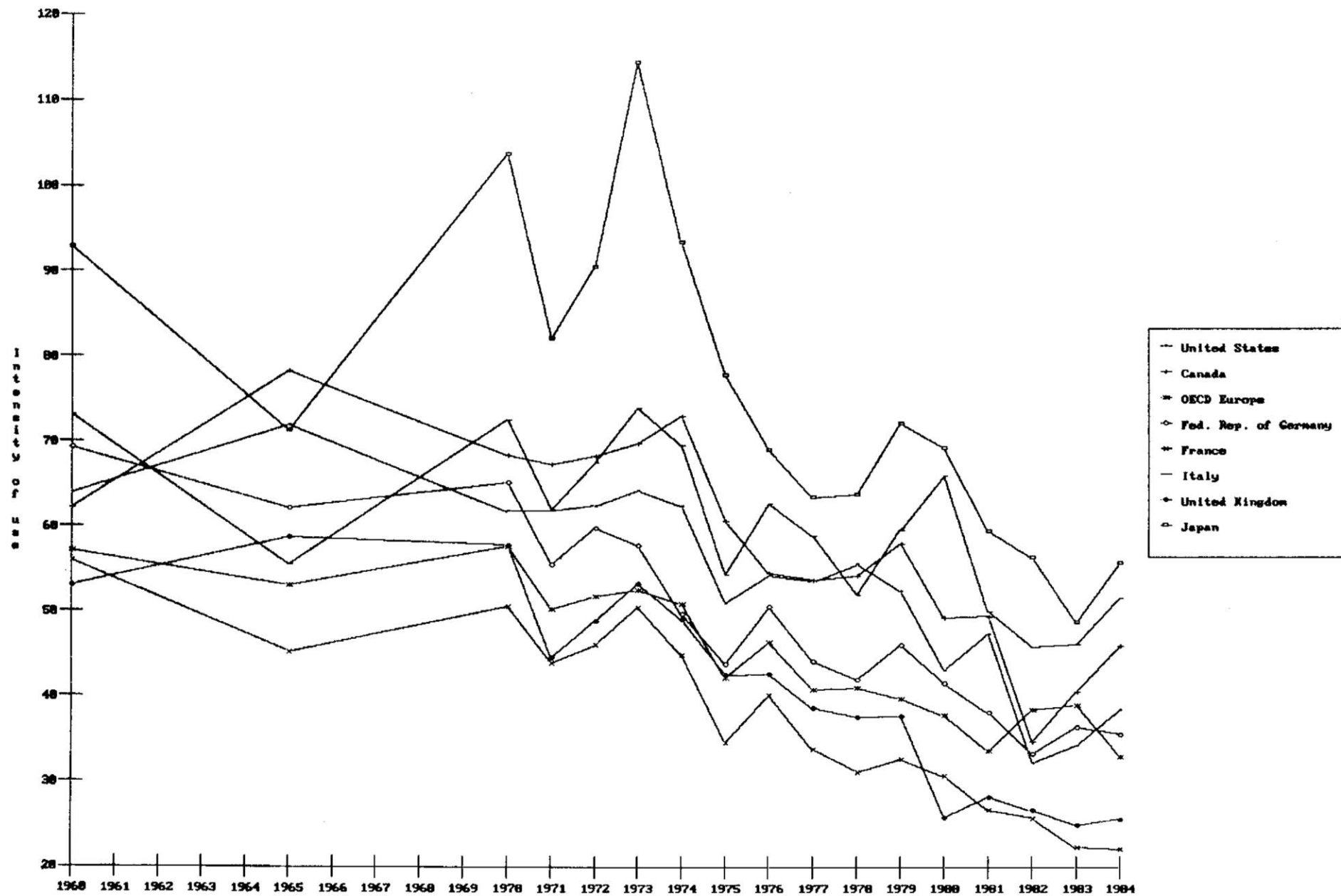
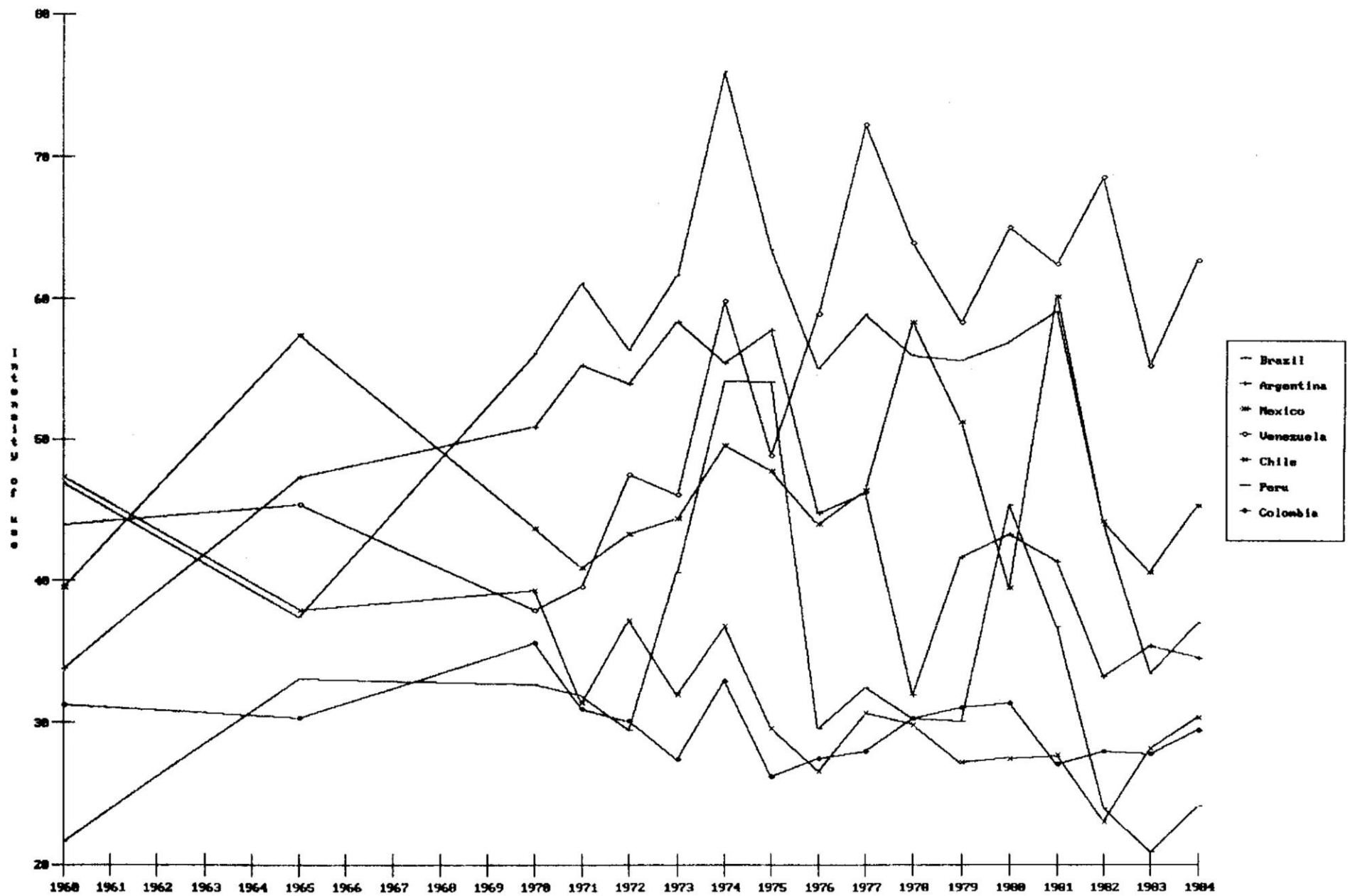


FIGURE 3b
STEEL



More ambiguous is the case of aluminium. Most OECD countries, except for Canada and the United Kingdom, have shown a rising trend over the period (Figure 4 a and b), with wide variations in intensity as in other metals. The use-intensities of the United States and Canada, major aluminium producers, have dropped substantially since the beginning of the present decade. The less-than satisfactory demand for this metal, during the first half of the 1980s may be partially linked to a decline in several end-use sectors: construction applications continue to lose markets to plastics, especially with depressed oil prices, and packaging (i.e., beverage containers) is rapidly approaching saturation. Nonetheless, the coming years, as projected by the United States Bureau of Mines, might witness a moderate increase in United States domestic consumption, even though a use-intensity decline is forecasted for 10 of the 21 end-uses considered (United States Bureau of Mines 1986 a).

The use-intensities for all four Latin American countries examined show a rising trend, with a most marked increase in recent years in Venezuela. Recent intensity levels, except for Mexico, are not substantially lower than those of OECD. In terms of per capita consumption, however, in 1984 Brazil recorded a consumption of 2.3 Kg, Argentina 3.2 Kg, Venezuela 5.2 Kg, and Mexico an extremely low level of 0.72 Kg, whereas the United States accounted for 19.3 Kg, Canada 11.7 Kg, OECD Europe 9.5 Kg, Japan 14.6 Kg and the Federal Republic of Germany 18.9 Kg. The per capita consumption for developing countries as a whole is in the 0.7 Kg range (United States Bureau of Mines 1986 b), so that it is theoretically plausible to accommodate production expansion of this product in the future, without market saturation. Another element in favor of developing countries is the production contraction in some DMECs. Most remarkable is the case of Japan, whose primary aluminium production dropped from 1.2 million tons in 1977 to 0.23 million in 1985, mainly due to its high electricity costs.

Unlike aluminium a more uniform intensity pattern is found in copper (Figure 5 a and b). All OECD countries have scored a marked reduction in intensity, with the UK and Canada being the most affected. As UNCTAD (1986 a) asserts, over the long term, the relationship between consumption and industrial activity has been worsening: during the period 1953-1955 to 1973-1975, a 1% increase in industrial production entailed on average an increase

FIGURE 4a
ALUMINIUM

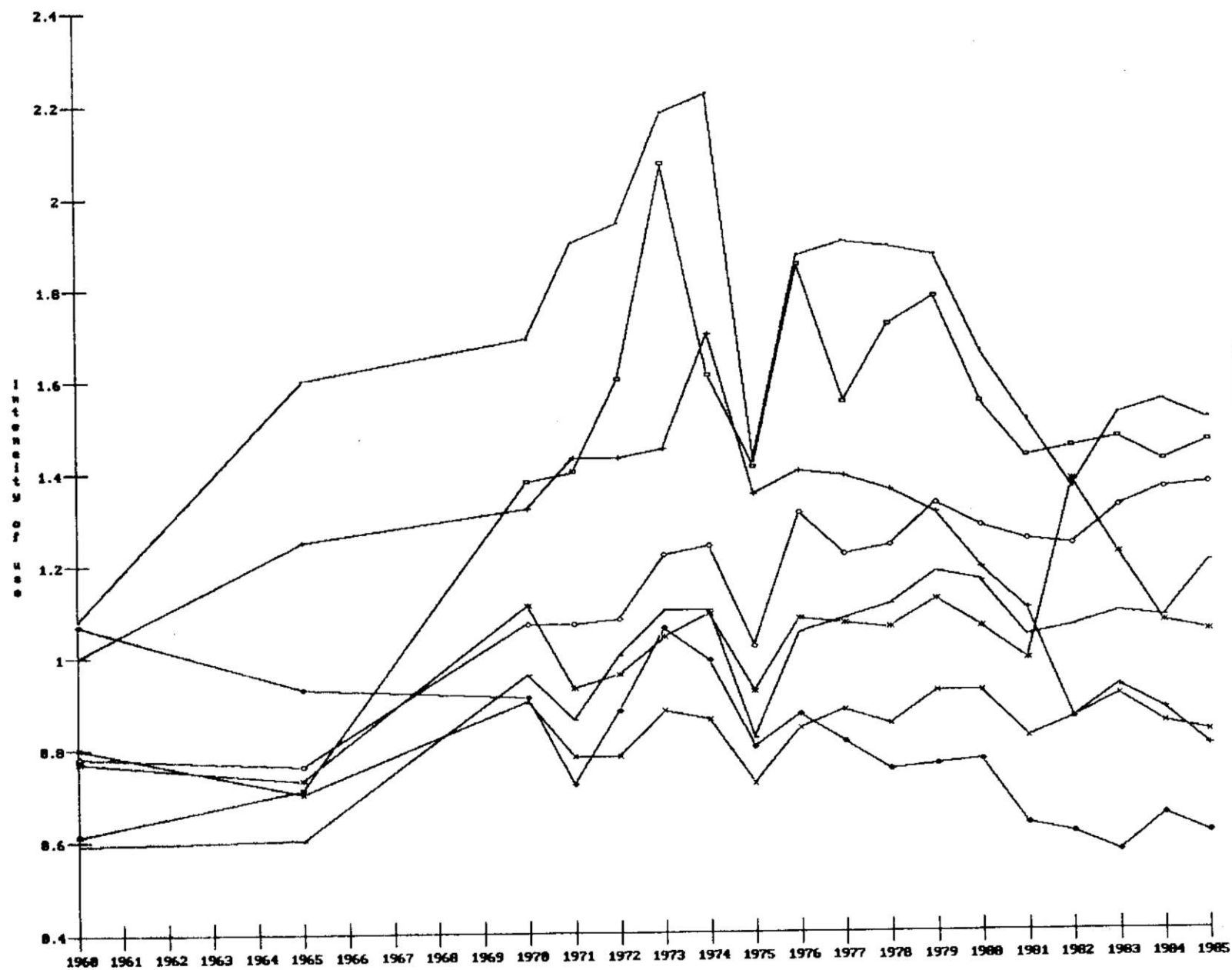
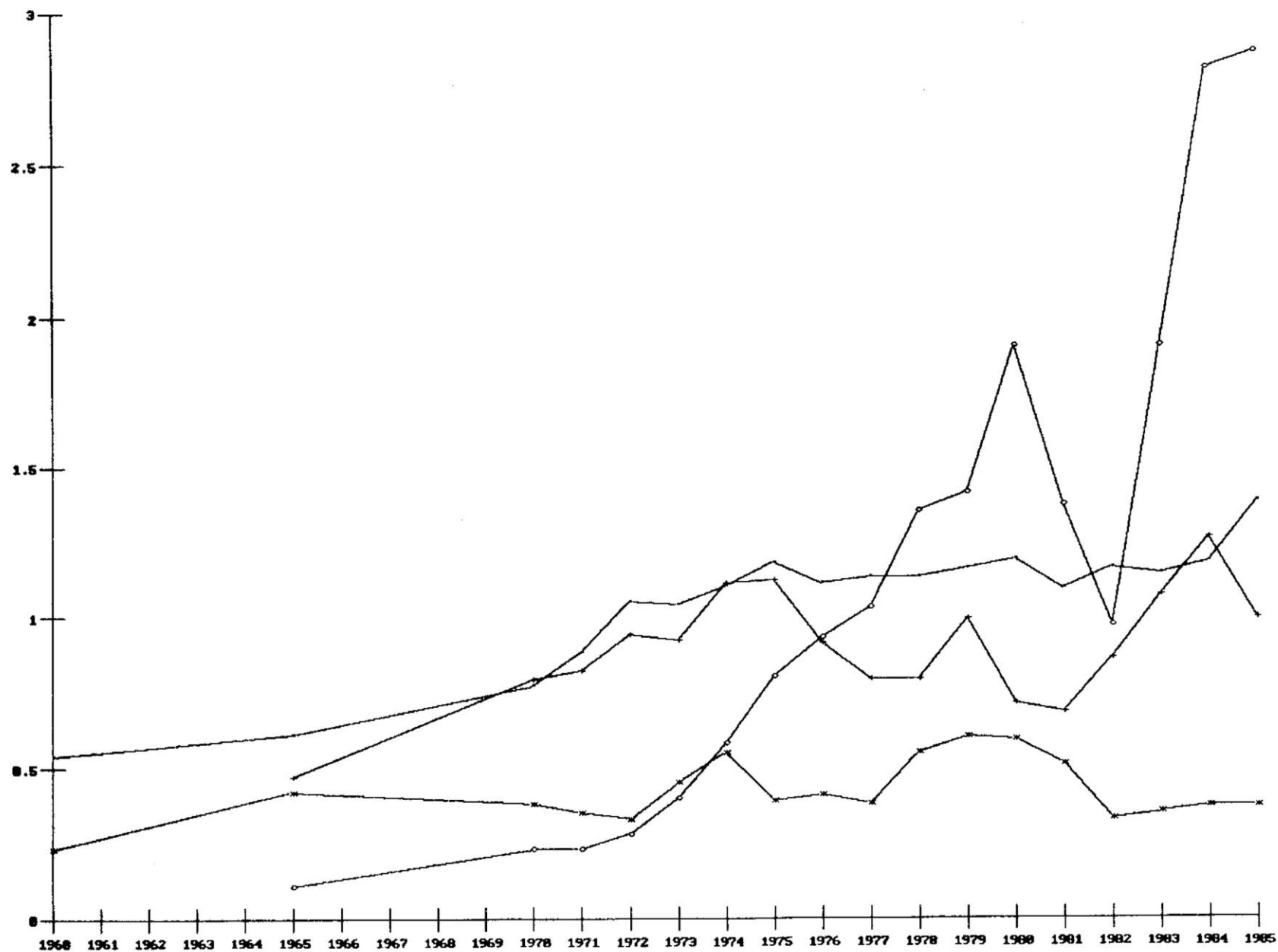


FIGURE 4b
ALUMINIUM



of 0.68% in copper consumption; whereas during the more recent period (1973-1975 to 1983-1985) the latter fell to 0.58%. This took place during a period when the price of copper was severely depressed. The decline is often attributed to automotive and product downsizing, design changes to conserve materials or increase efficiency, and substitution primarily by aluminium. This decline is likely to continue in the future, because of an increasing use of aluminium in automotive radiators and of optic fibres in telecommunications.^{21/}

A gradual increase in intensity is evidenced for the Latin American countries, except for Chile, which shows a much higher one, but with a large year-to-year fluctuation. Regarding per capita consumption, again these countries' levels (Argentina 1.2 Kg, Brazil 1.3 Kg, Chile 3.0 Kg, Mexico 1.1 Kg and Peru 1.1 Kg) are far below the levels in OECD countries (FRG 12.8 Kg, Japan 11.4 Kg, United States 8.6 Kg, Canada 9.2 Kg). The estimated average level for developing countries is around 0.48 Kg. The outlook for increased consumption depends, to a large extent, on the evolution of demand in developing countries. Considering the continuing applications of new technologies, it may not be realistic to assume that the use-intensity in these countries would reach the peaks previously achieved in the DMECs.

The most remarkable the slowdown in intensity has been in the case of tin (Figure 6 a and b). For all the OECD countries considered, there has been a consistent deterioration throughout the period, and the intensity in recent years is approximately one-third of that prevailing in the 1960s. For example, between 1973 and 1986 tin consumption in the United States dropped from a high of 59,100 tons in 1973 to 38,000 tons in 1986, in OECD Europe, from 65,900 to 56,400 tons, and in Japan, from 38,700 to 31,500 tons. Overall consumption in the DMECs declined by an average of 3.2% per annum. The contraction in use can be attributed mainly to material substitution, the most notorious one being the replacement of tinplate by tin-free steel and aluminium in beverage containers. Material saving technologies have also played a role: for example, the tin content of stabilizers used in the manufacturing of PVC (polyvinyl chloride) --a resin which is the basic raw material for a wide range of products such as pipes, window frames and similar items-- declined by 50% in a decade, and the coating thickness of tinplate has lessened substantially. The

United States Bureau of Mines (1986 a) projects for 1982-1993 a compound annual domestic consumption rate of -3.2%.

In contrast to the OECD experience, developing countries showed a modest 0.9% annual increase in tin consumption during the 1973-1984 period, thanks specially to a steady increase in tinplate production. However, the use-intensity of the Latin American countries has suffered a reduction during the last two and a half decades, so that in 1985 it was not so significantly different from that in the OECD countries. Per capita consumption of developing countries is, however, known to be extremely low, even compared to the already reduced level of the OECD countries. For example, the average annual consumption of the United States in the 1980s has been in the range of 150-200 Kg per 1000 inhabitants, while that for Brazil or Argentina stands at 25 to 40 Kg. In the light of these observations, any leveling-off or reversal of the decline in world tin consumption will require continued efforts to expand its consumption in developing regions and to find new uses for it.

The use-intensity for lead in the OECD countries has performed relatively well in comparison to tin or even copper (Figure 7 a b). In two countries, Italy and Canada, a positive growth has been recorded. Among the four Latin American countries which are lead producers, Peru has shown a rapid increase in intensity while Mexico, the biggest regional producer, has suffered a substantial decline. During the 1970-1984 period, world consumption of refined lead metal increased by 1.5% per annum, spurred by a 4.6% growth rate in developing countries. The equivalent for the industrial countries reached only 0.2% per annum.

The development of substitutes such as plastics for cable sheathing, a lower lead content per average auto battery coupled with its longer life, and, in particular, the health and environmental concerns which reduced the use of gasoline and pigments for paints, have all exerted a strong negative influence. Many of the environmental and technological factors that reduced lead consumption, however, have not yet played a critical role in most developing countries. Rather, a comparatively strong growth stems from demand increases in domestic infrastructure (cable sheathing, paints), manufacturing (chemicals) and vehicle production (batteries). Though these factors gradually influence the consumption pattern of developing countries, it may take some

FIGURE 5a

COPPER

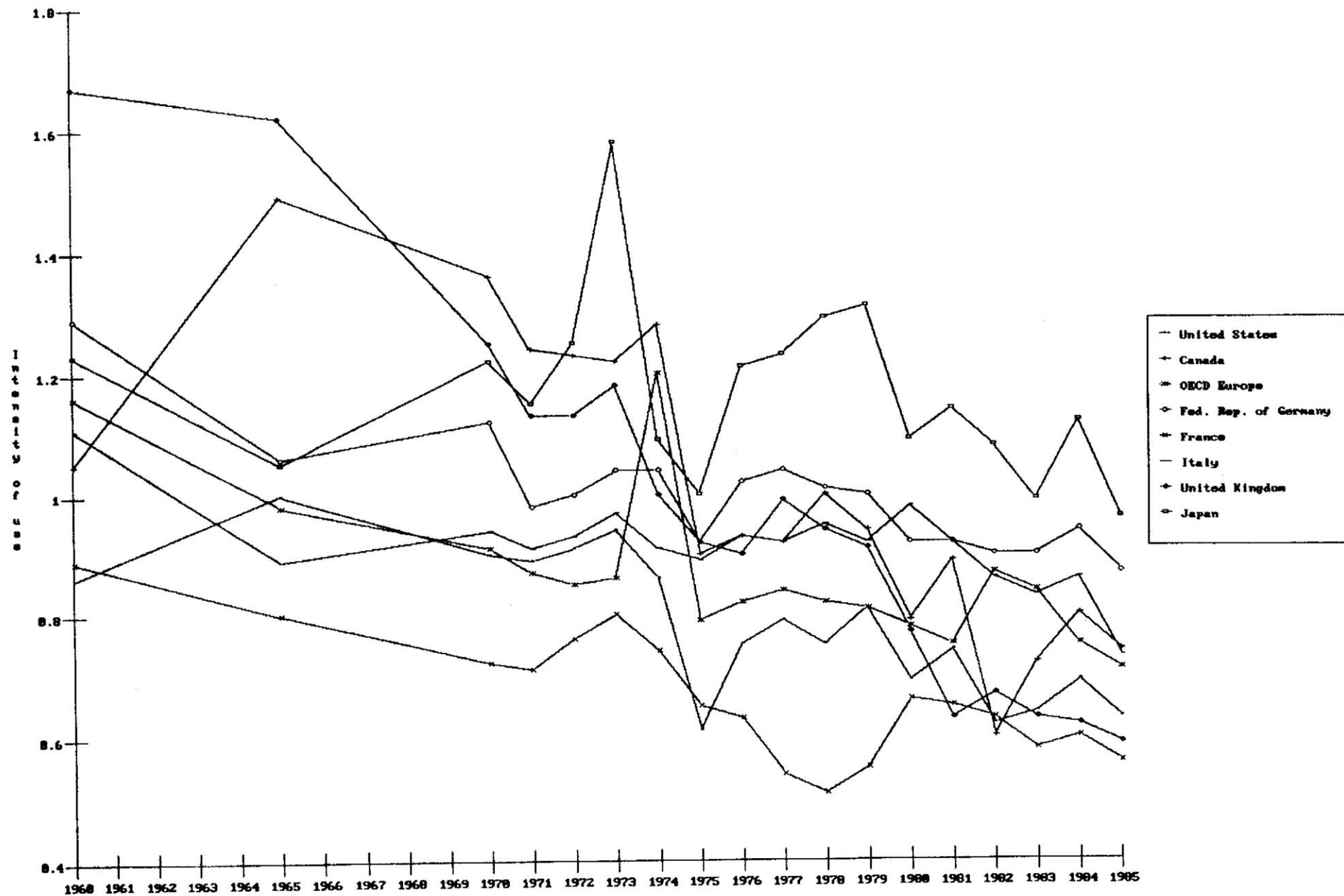


FIGURE 5b
COPPER

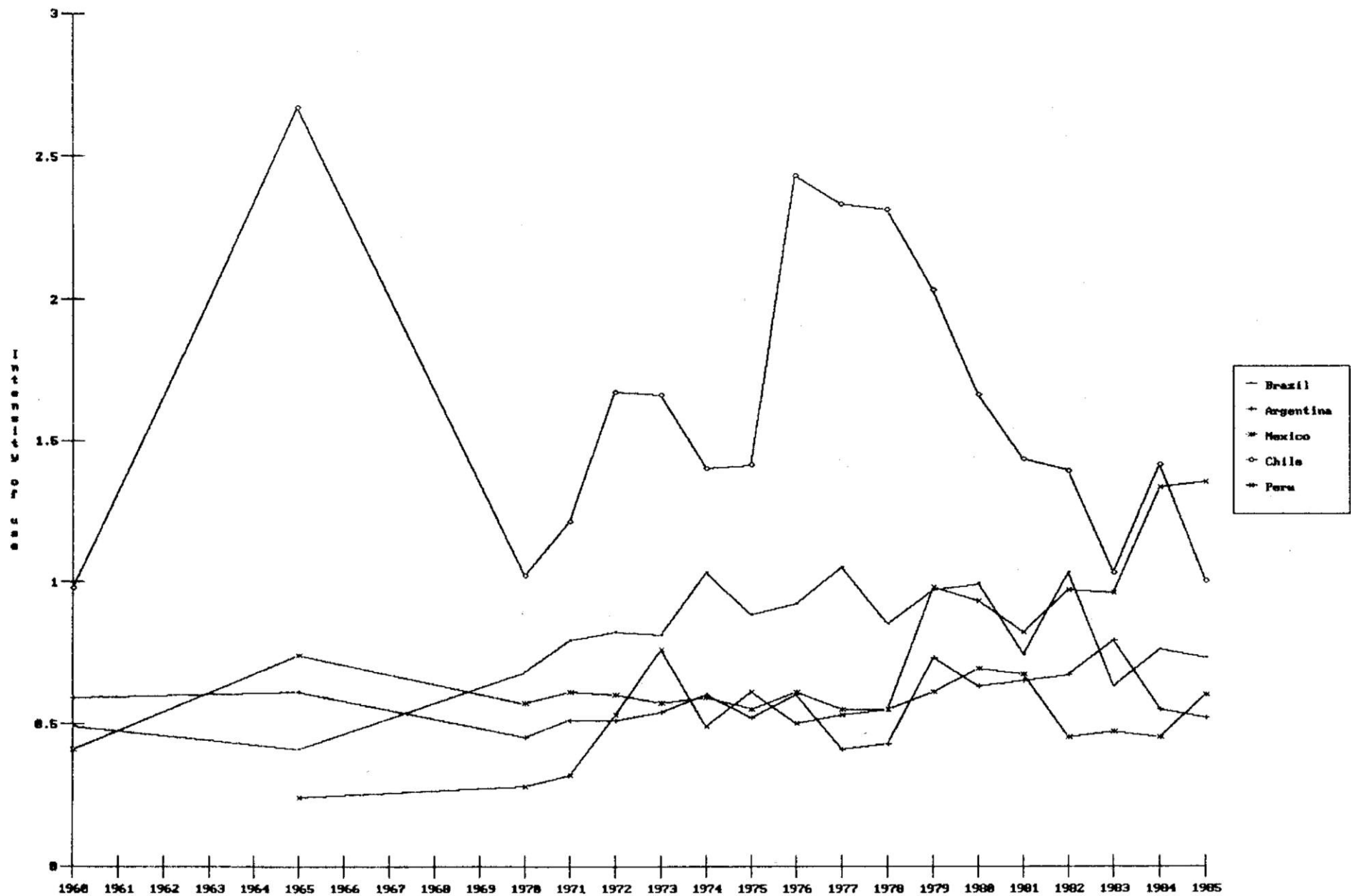
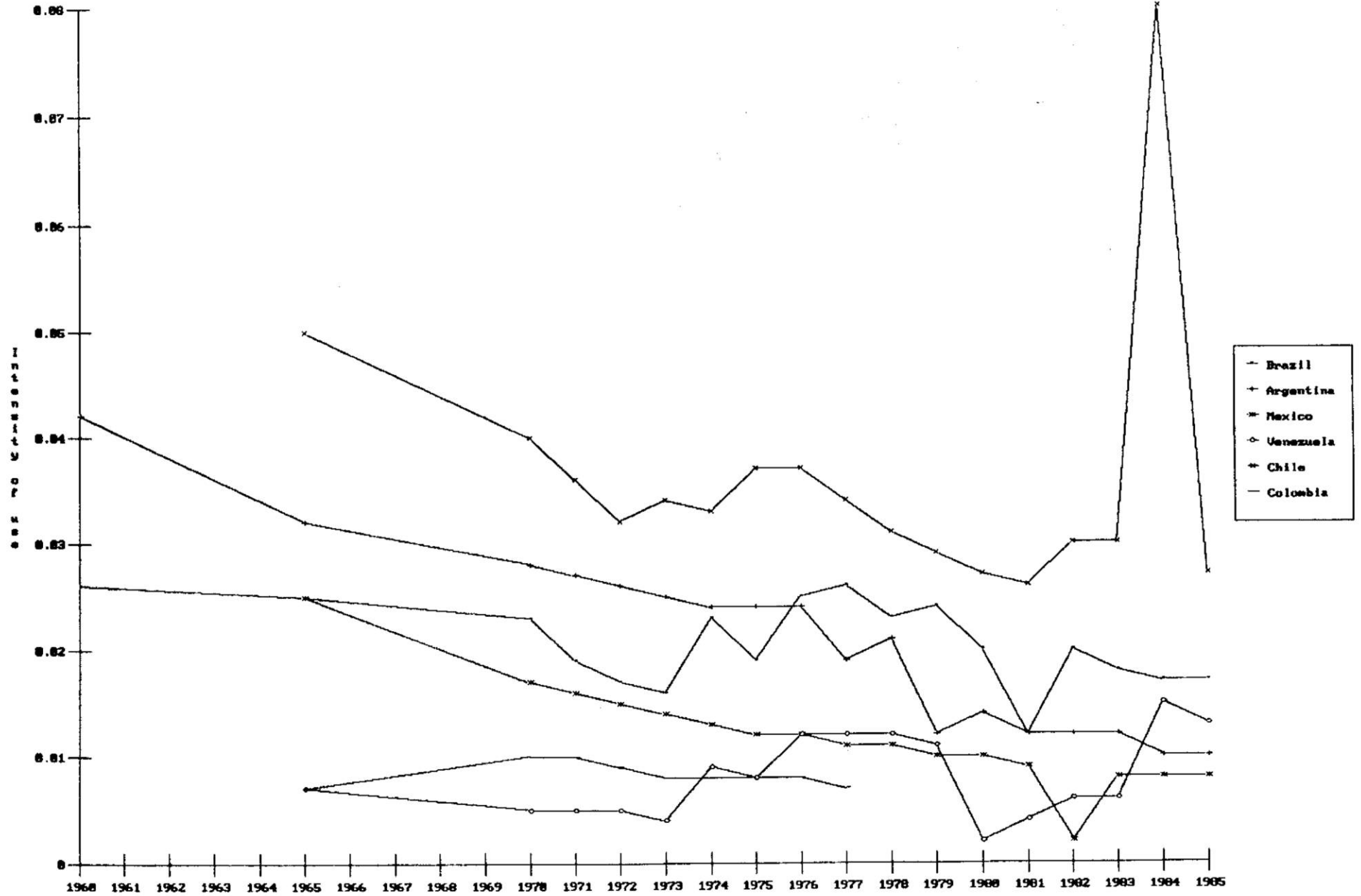


FIGURE 6b

TIN



time before the wide existing gap in per capita consumption between the OECD and developing countries is closed: in the mid-1980s, per capita consumption for OECD on average was well above 3.5 Kg, in contrast to 0.250 Kg for developing countries as a whole. One of the major consumers of the region, Mexico, reached 1.1 Kg in 1984.

In zinc, all the OECD countries considered, except for Italy, recorded a marked decline in use-intensity (Figure 8 a and b). Japan, the world highest-intensity user, reduced its peak of 1.07 tons in 1973 to 0.61 tons in 1985. That of the United States for the same period went down from 0.59 tons to 0.31 tons. The Latin American countries as a whole have recorded a more stable pattern, except for Peru, a major world producer, which showed a very erratic behaviour.

World consumption of refined zinc for 1970-1984 barely grew by 0.8% per annum, in contrast to 5.4% in the preceding ten years. An important element has been material substitution and new material-saving technologies (e.g., substitution by plastics and reduced consumption in diecastings). While zinc consumption in the OECD countries declined by 1.3%, that for the developing world increased by 6.1% per annum. In Latin America, Brazil, one of the major zinc users, increased its consumption by 5%. The rapid increase in consumption in developing countries is closely related to infrastructure requirements such as major construction projects, highway building, and the expansion of durable goods manufacturing. Yet, in these countries per capita consumption remains low: their average consumption in 1984 was 0.37 Kg against 6.5 Kg of Japan or 4.1 Kg of the United States. Mexico's 1.3 Kg, Rep. of Korea's 1.2 Kg and Taiwan Province of China's 1.8 Kg are far above the developing countries' average but far below the figures corresponding to the developed world. Also, the likely growth of major consuming sectors and an increase in exports of zinc-containing intermediate products such as galvanized steel should lead to a demand increase in these products.

The industrial cases studied above lead to the conclusion that most developing countries find themselves at a development stage where the unit input of materials and energy needed to produce an additional unit of GDP is likely to expand for some years to come. Any reduction in per capita material requirements thanks to miniaturization, economization and substitution might

FIGURE 7a
LEAD

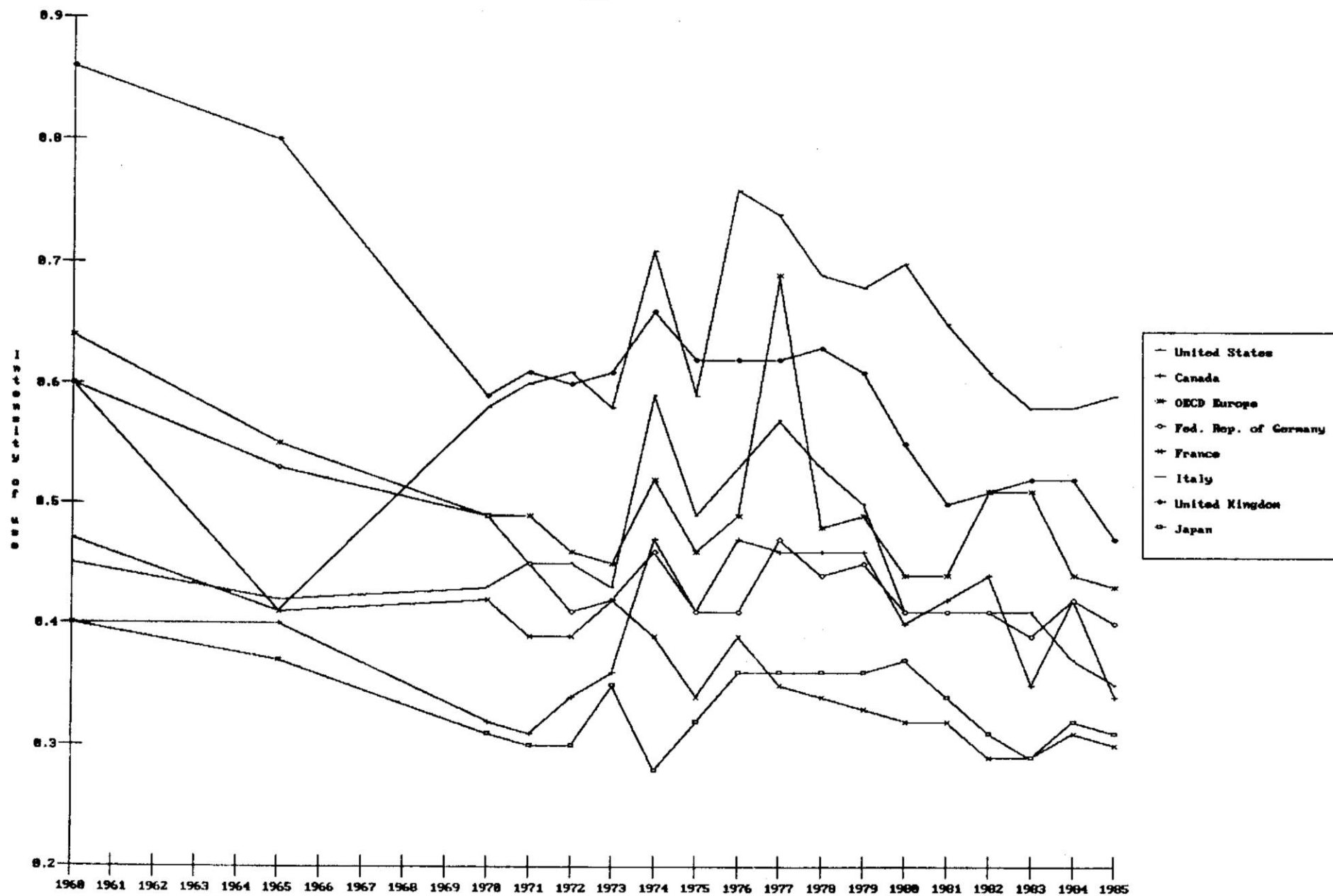


FIGURE 7b

LEAD

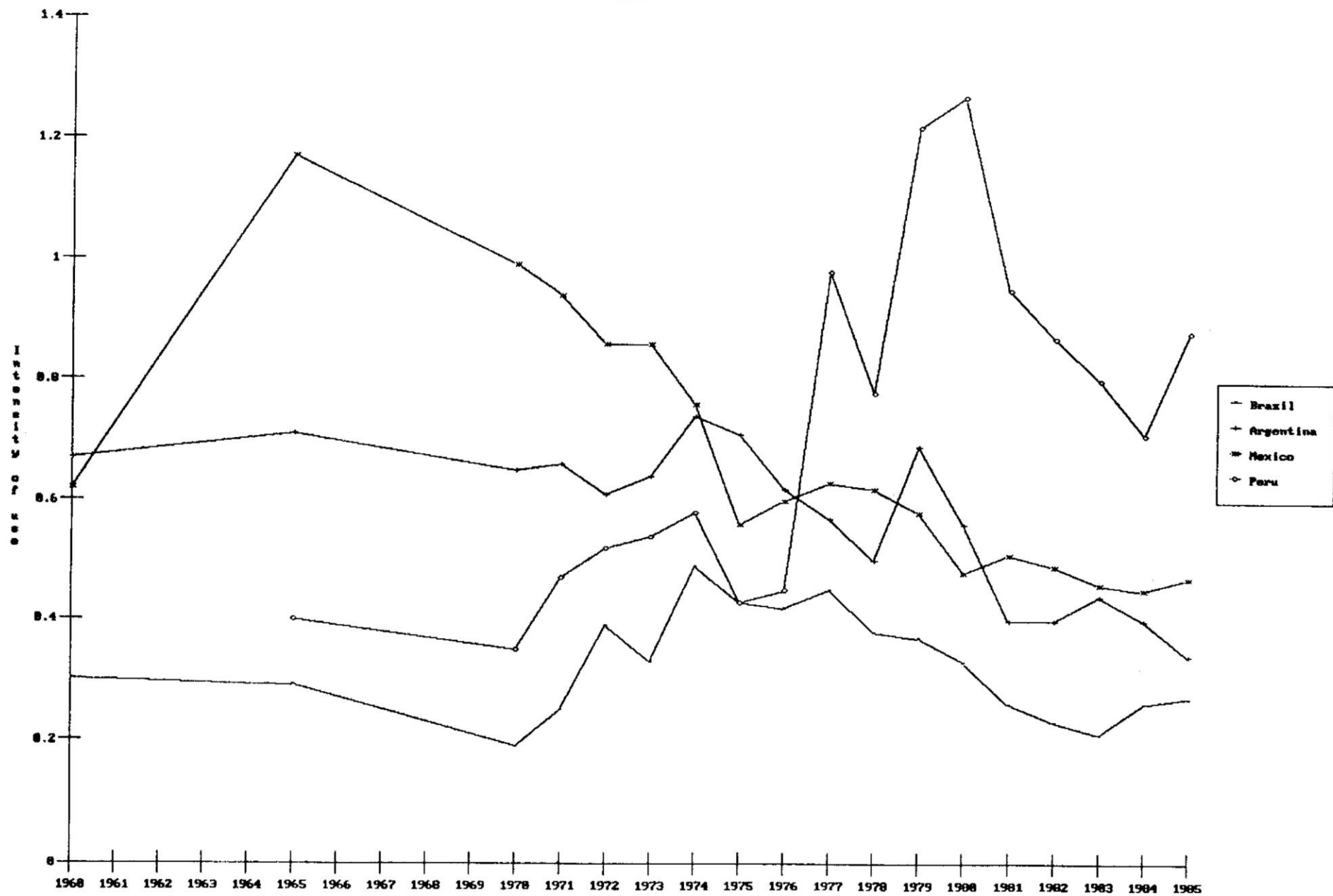


FIGURE 8a
ZINC

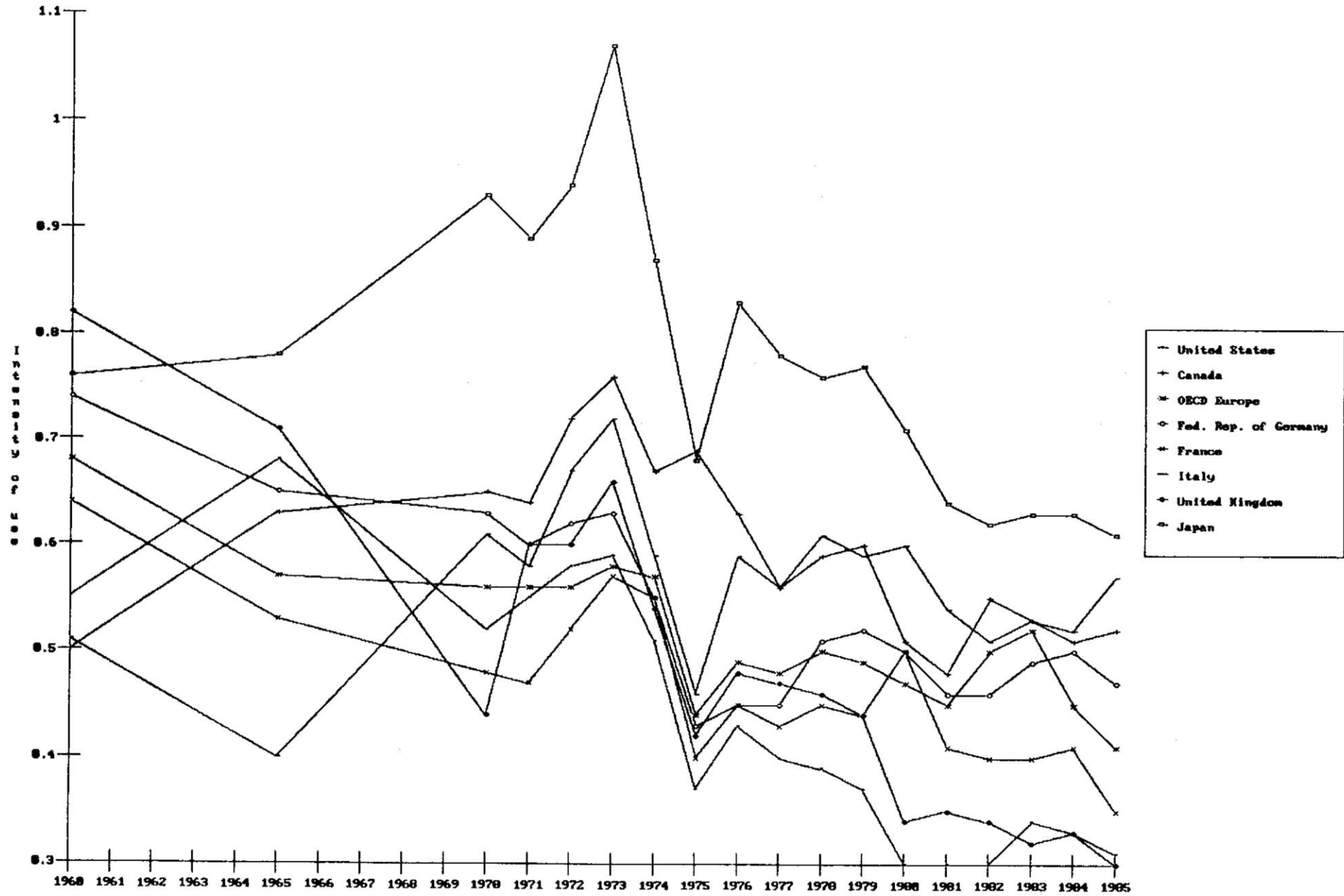
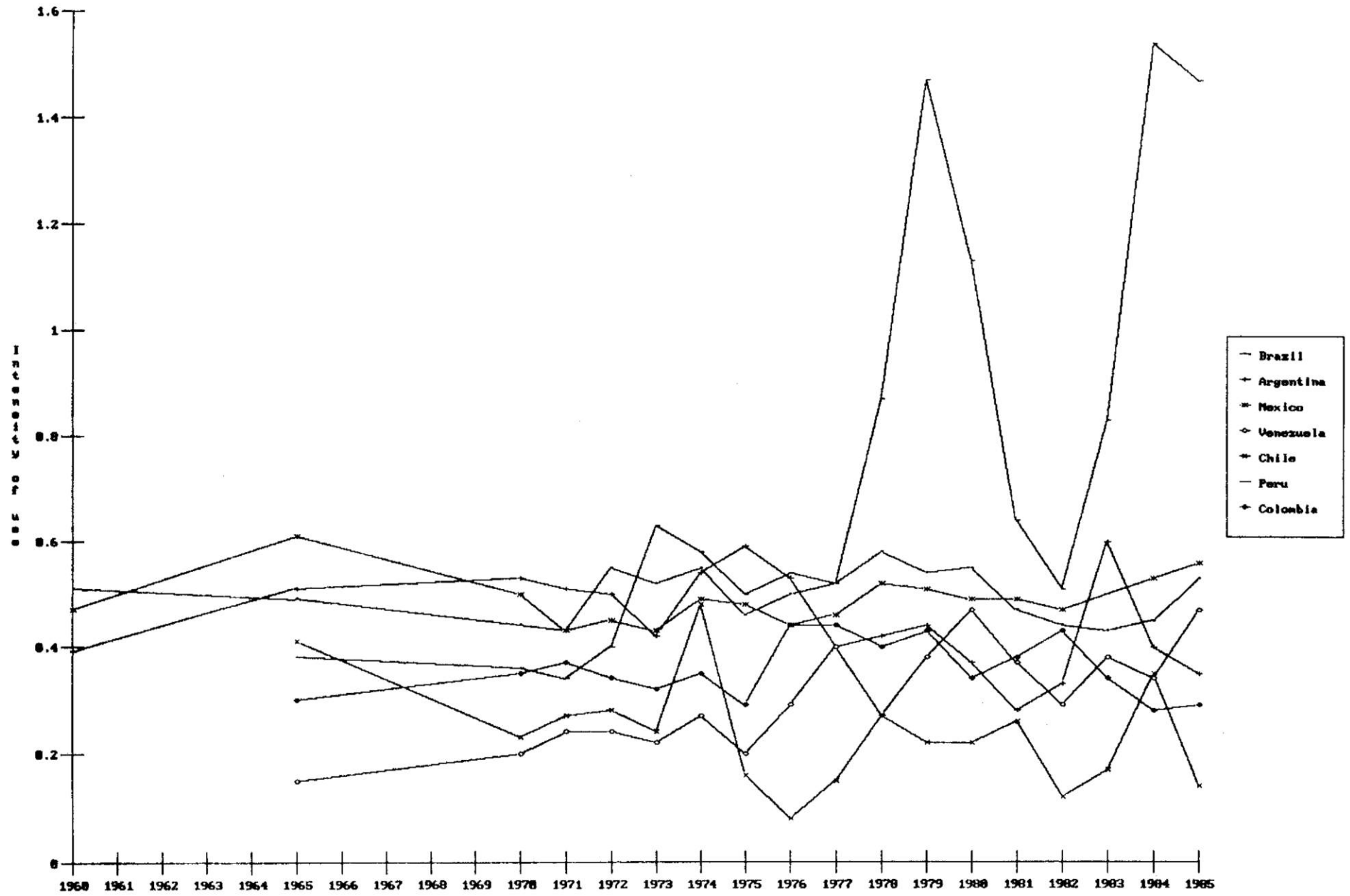


FIGURE 8b
ZINC



be offset by increasing material requirements, mostly traditional, due to an accelerated population growth, a need for infrastructure works, materialism and consumerism.^{22/}

b) Agricultural products

It appears inappropriate to apply them the concept of intensity of use, due to their low income elasticities. It appears more useful to analyze instead their consumption growth pattern, especially for food and beverages. Effects arising from the change in the product composition of income would be smaller here.

For this reason, Table 3 examines trend annual growth rates of consumption of agricultural commodities, for three different time periods (1963-1972, 1973-1984, 1980-1984), both in developed and developing countries. In the food and beverages item, though the majority of its components registered a slowdown in their worldwide consumption from 1963-1972 to 1973-1984, some have achieved an increase in developing regions. In the cases of sugar, tea and palm oil, consumption growth in developing countries more than offset the decline in consumption in the DMECs. For the developed world as a whole, only cocoa scored an increase in trend between 1963-1972 and 1973-1984, since foodstuffs consumption in these countries has been severely curbed. It is noteworthy that even in the developed world some commodities --such as bovine meat, wheat, rice, coffee, cocoa, groundnuts, etc.-- have scored an improvement during 1980-1984.

Among agricultural raw materials, two products, unmanufactured tobacco and jute products managed to improve their consumption rate worldwide. Both of them, presumed to have been exposed to either health campaigns or competition from synthetics, also recorded an increasing rate for developing countries. During 1980-1984, the DMECs improved their consumption rate of raw cotton, rubber, sisal, wool, veneer sheets and plywood, in comparison with the 1973-1984 period. It should be stressed that this took place when DMECs macroeconomic indicators had worsened substantially.

The above analysis points to diversified consumption patterns among agricultural and metal products across different time spans and regions. In addition to the level of economic activity, other factors such as changes in consumer preferences, the level of supply and demand influenced by

Table 3

TREND ANNUAL GROWTH RATES OF CONSUMPTION OF INDIVIDUAL AGRICULTURAL COMMODITIES
(Per cent)

	World			Developed Countries			Developing Countries		
	1963 to 1972	1980 to 1984	1973 to 1984	1963 to 1972	1980 to 1984	1973 to 1984	1963 to 1972	1980 to 1984	1973 to 1984
<u>Food and beverages</u>									
Bovine meat	3.3	1.3	0.9	3.2	1.0	0.0	2.4	1.5	2.6
Wheat	4.0	2.7	2.4	2.7	5.1	2.5	4.5	4.3	4.1
Rice	3.1	2.9	2.7	-1.8	5.6	-1.2	2.9	2.6	3.0
Maize	4.2	-1.0	2.5	4.6	-2.5	1.4	3.5	0.9	3.9
Bananas	2.9	0.5	2.5	4.8	0.1	0.5	2.2	0.4	2.8
Sugar	1.7	2.7	2.7	2.7	-1.6	-1.4	6.5	4.1	4.7
Coffee	2.5	1.7	1.1	1.5	1.5	0.9	2.5	0.4	-0.1
Cocoa	2.3	3.4	0.9	1.3	4.5	1.8	18.9	-0.9	2.8
Tea	2.4	3.4	3.5	0.7	-0.5	-0.7	3.7	4.2	4.5
Soyabeans	7.7	0.3	5.1	6.8	-1.1	2.8	16.2	4.9	13.1
Groundnuts	1.1	2.7	0.1	-0.4	4.5	-2.4	1.5	2.5	0.6
Copra	2.1	-4.1	0.4	-2.2	-11.7	-13.8	3.9	-3.6	2.5
Palm oil	6.8	6.2	9.3	8.3	-0.5	-1.5	5.9	7.3	13.1
<u>Agricultural raw materials</u>									
Tobacco unmanufactured	0.3	2.3	2.0	-0.6	-1.9	-0.4	1.0	1.3	1.8
Cotton raw	2.4	1.6	1.5	-1.2	0.9	-1.0	4.0	2.5	1.9
Rubber	4.0	3.1	1.5	3.6	2.2	0.2	16.9	5.4	5.4
Sisal	-0.2	-5.3	-5.0	-2.6	-3.3	-10.3	5.2	-7.6	-3.0
Jute products	-0.8	-2.6	1.1	-2.7	-5.9	-5.7	0.1	-3.9	3.8
Wool	1.1	1.9	0.7	-0.6	0.6	-1.5	3.8	4.2	2.8
Sawlogs non-coniferous	3.5	-1.8	0.3	2.2	-6.1	-2.5	8.0	1.7	4.0
Sawnwood non-coniferous	2.9	-1.3	0.8	2.6	-4.3	-2.3	6.0	1.0	5.6
Veneer sheets	9.2	-2.3	1.4	6.9	2.2	-0.1	13.0	-8.9	6.5
Plywood	7.5	2.4	0.3	7.7	1.7	-0.9	11.2	6.1	9.9

Source: UNSO statistics; UNCTAD, Commodity Yearbook 1986; International Commodity Organizations and FAO data. Taken from UNCTAD (1987 a)

protectionism and the pace of structural and technological change are affecting strongly consumption patterns.

3. Limitations of the concept, its applicability and factors responsible for varied consumption patterns among countries

The concept of use-intensity is a useful instrument to identify future raw material consumption patterns of developed and developing countries. However, it is important to bear in mind several restrictions that this concept inherently entails.

Firstly, consumption data at the country level reflect more the consumption measure employed in fabricating activities than in "final" consumption. Dealing with imports and exports becomes problematic when these occur not only at the primary stages but also further along the production process, since there is a high probability for many imported/exported products to contain raw materials. Copper estimates, for instance, disregard imports/exports of semifabricates or more importantly manufactured goods containing copper, as in automobiles. While it is not often possible to quantify the trade in copper-containing goods, the level of international trade in these is substantial.^{23/} The degree of underestimation for the United States primary non-ferrous metal manufacturing, as pointed out by one study (United States Bureau of Mines 1986 a), can be remarkable: metals contained in imported intermediate production goods are believed to have added 21 % to imports in 1978, 21.5 % in 1979 and 25.2% in 1980.

The applicability of the hypothesis is also somewhat restricted by the fact that technological progress which influences demand, takes place in a discrete manner at an irregular pace, and that material consumption patterns have been strongly affected by great demand spurts as new markets open up for individual products. Well-known cases are the introduction of the Bessemer process late during the last century which enabled a massive scale production of steel, and the emergence of the electrical industry which created a new huge market for copper. Problems arise when a similar level of GDP per capita in constant prices between countries is achieved so many years apart, during which it is highly possible for a series of demand augmenting/reducing

technologies to emerge. Extreme examples are the United States and Brazil which attained a level of GDP per capita in constant 1980 dollars of \$ 1500 at points in time roughly 100 years apart, and the United States and Mexico of \$ 2580 roughly 75 years apart. The study by Radetzki (1987) reveals that the intensity of use hypothesis --a lower intensity at the same level of income for a late-comer-- is vindicated only in the case of lead for a United States-Brazil comparison, and for United States and Mexico, the hypothesis stands for copper, lead and zinc, but not for aluminium, nickel and steel.

As the Radetzki study asserts, there are additional factors which work to distort the predictions of the hypothesis. His analysis on India points first to the role of government policies that affect consumption levels of materials. A high use-intensity in three metal-intensive sectors (ie., manufacturing, railways and electricity, and gas and water) reflected India's choice for heavy industry and infrastructure in its 1955-1965 development plans. Secondly, in addition to natural resources' endowment, foreign exchange shortage might encourage the government to pursue material substitution of those with a high import dependence, aiming at achieving greater self-sufficiency. In India, for a long time, domestic output has accounted for a very high proportion of aluminium and steel consumption, while one half or more of the consumption requirements in copper, lead and zinc have to be imported. Therefore, government encouragement for the consumption of the former and discouragement of the latter group resulted in a clearly distinct pattern of consumption than otherwise.^{24/} Government promotion of some selected products, as in India, would lead to changes in relative prices, a frequently resorted instrument for this purpose being import duties. Sheer supply shortages arising from production rigidities or mismanagement in import planning, and last, but not least, cultural factors also condition materials demand along patterns appreciably distinct from those postulated by the hypothesis.

From this examination based on the intensity of use, some reassuring and disquieting elements may be drawn. On the negative side, it is undeniable that some materials have been losing their competitive edge against other natural, synthetic or compound materials, and that per capita consumption or use-intensity of traditional materials in a large number of developing countries

in traditional materials would not reach the level experienced earlier by developed countries. On the positive side there still seems to exist a good potential for future materials growth in developing countries and particularly, in the faster growing ones like the NIEs. It is also possible to create a number of final demands leading to an intensive use of available natural resources of regional importance. Also, it is possible to identify some end-uses (e.g., the electrical and electronics sector in copper) which are expanding faster than industrial production both in the industrial world and developing countries. The fact that some end-uses have scored important improvements in intensity, even for products whose overall consumption is negative, points to the differentiated performance in each product usually hidden by the overall tendency. This, in turn, reconfirms the importance of systematic R & D for the purpose of finding new uses and products.

III. TECHNOLOGICAL INNOVATION AND COMMODITIES' COMPETITIVENESS AGAINST SUBSTITUTES: SOME COMPARATIVE CASES

It might be gathered from the foregoing that some products have been able to "defend" their demand relatively well by creating new end-uses, while others have suffered from the absence of these innovations. To reflect on this differentiated performance record, a pair of metals and a group of agricultural raw materials are examined in this section, in order to draw some lessons from past experiences. The products concerned are of high regional importance.

1. Aluminium and copper

What is argued essentially here is that a high aluminium consumption growth rate --during the 1960-1979 period at over 8.5% per year, compared with 3.5% to 4.0% for copper, lead and zinc, and less than 1.0% for tin--^{25/} is due not only to properties of aluminium itself and its comparatively recent introduction as an industrial material, but also to the high degree of industrial integration prevailing in the bauxite/ alumina/ aluminium industry. The most outstanding features of this industry have been: a stable pricing regime, at least up until recently; an orderly development of production capacity; a high degree of direction and concentration in research aimed at expanding its use; and the ability of major transnational producers to invest in manufacturing facilities to bring new products into the markets. By contrast, efforts made in copper to discover, develop and promote new uses have proven insufficient, and rather, the industry has centered its efforts on expanding primary production.

As pointed out by Mardones et. al. (1986) and Schindler (1987), the gradual vertical "de-integration" process of the post World War II era produced a situation in which copper arrived increasingly to the final markets through semimanufacturers who are many in number and have no links, either formal or informal, with raw material producers. These semimanufacturers, who also produce items made of other metals, have no special interest in promoting copper use over others. Primary copper producers, on the other hand, do not have access to final consumption markets where demand is actually

determined. The lack of market intelligence on the requirements of end-fabricators has made it difficult for them to promote copper, despite a recent rising awareness of the need to create such links.

By contrast, the bauxite/alumina/aluminium industry has been characteristically highly integrated. The six TNCs, joined by some other second-tier companies whose primary interest is in aluminium, continue to dominate the industry (for the industrial structure, see UNCTAD 1984 a). There exist co-operation and co-ordination channels between aluminium producers and fabricators. Most of the TNC aluminium output is not traded outside the network but is fed into their affiliate fabricating capacities.^{26/} UNCTAD states that four out of the six TNCs have capacity to fabricate over 90% of their aluminium output and the other two between 70 and 90%, leaving comparatively little uncommitted aluminium to independent fabricators. This situation also holds valid for most of the second-tier producers in the DMECs, channeling most of their aluminium output to associated fabricating plants.

A fundamental strength of the aluminium industry in research and promotion is the amount of funds which a company like ALCOA or ALCAN allocates to these objectives --major companies spend more than US\$100 million annually-- and the nature of these efforts. Kuczynski (1982, p.26) cites the example of ALCOA, the leading company in the fabricated end of the business, mobilizing its research team on the two-piece can manufacturing process and later promoting this process throughout the world. He concludes, "I really do not think that this could be done, if, in the case of copper, a promotion centre makes a discovery of that type since the gap between promotion and marketing is just too large. And there is not really enough of an equity stake in the promotion centre on the part of the fabricators and certainly of the mining companies to try to push the discoveries and make them profitable as fast as possible".

In copper, research on new and traditional uses has been relegated to independent institutes and centers such as the International Copper Research Association (INCRA) and the Copper Development Association, or international organizations like CIPEC. Although these are funded either separately or jointly by both producers and consumers, they are not directly associated

with either the production process or the marketing system, not to mention the meager amount of funds allocated for such purpose.^{27/} The copper industry as a whole has reportedly spent in 1985 in marketing and research about 0.1% of the total value of sales of refined copper. In market-oriented industries such as plastics or wool, the comparable figure would be in the 3 to 5% range (Financial Times 1986). Chile, the largest producer, spends roughly \$ 200,000 annually for promotion purposes, in spite of a proposed annual goal of \$ 3 million and an eventual creation of a Center for Promotion of Copper Use (Morales 1987).

Better co-ordination in aluminium than in copper between demand and supply sides seems to have produced a distinct pattern of response in production to the depressed prices in the first half of the 1980s. Primary aluminium production reached its peak of 12,77 million tons in 1980 and later in 1982 it was brought down to 10.7 million tons, that is, a reduction of 16.2%. During this period, real consumption fell less drastically, so that by the end of 1982, consumption was running at a higher rate than production. In copper, however, a 5.7% reduction in consumption during 1980-1982 was accompanied by a 1.2% production increase in refined copper, with the net result of considerable accumulation of stocks. Stobart (1984) attributes this to the difference in industrial organization: aluminium is managed by a limited number of integrated privately-owned producers, whereas copper has a much higher level of government ownership. Many of the largest copper producers are under Third World state-ownership and they see it as in their interest to maintain or even increase production during recession in order to sustain foreign exchange earnings and employment.

Another distinct feature between both industries is their pricing regime. In aluminium, up until recently, most producers maintained little-fluctuating price quotations in individual markets.^{28/} Refined copper has also a two-pilar price system, through commodity exchanges and through Producers' prices, the price of the London Metal Exchange being by far the most influential internationally. Even though major exchanges handle only a small share of world copper trade, their quotations act as the peg on which a much larger volume of copper contracts are based. These exchange prices are extremely sensitive to changes in demand and supply forces, speculative as well as real,

and hence fluctuate widely. As a matter of fact, refined copper at the world level had the highest export unit-value instability among various commodities during 1962-1981 (UNCTAD 1986 b). Price instability of copper undoubtedly has a negative impact by facilitating substitution.

Besides instability, the price differentials between both metals, which are competing substitutes particularly in electrical cable and wire markets, are worth mentioning. A rapid rate of copper substitution by aluminium in the 1950s and 1960s was related to the copper-aluminium price ratio distinctly favoring the latter as an electrical conductor. This was due to improved technologies and greater economies of scale, which enabled the aluminium price to drop in real terms. Part of the overall strategy of aluminium giants was to keep their prices low and stable, but "the main thrust of their policy was to establish price differentials based on the high level of vertical integration that the companies had attained" (Mardones et.al. 1985 p.7).

This paper by no means advocates in itself vertical integration and the likely implication of higher industrial concentration. It argues, however, that the contrasting performance between both metals sheds light on some important policy areas, not only for copper but also for other commodities. Firstly, establishing more direct commercial link between producers and end-users is essential. As producer-country marketing organizations are often absent when materials selections for major long-term projects are being discussed, alternative materials (say aluminium) are chosen in lieu of others (copper). It is crucial for producer-country organizations to have a minimum degree of representation when projects involving large amounts are evaluated. Instead of sending ad-hoc project missions it is better to maintain a permanent field office in the consuming country either in the form of a sales office or trading company which will feedback information on consumer needs. This type of information feedback system will allow the material producer to integrate forward into more diversified higher-processing product lines. In this light, attempts at forward integration, in production as well as services, arising from the producers' own initiatives or through joint-ventures, should receive a high priority.

Secondly, in view of the fact that copper price instability adversely affects its use, any promotion strategy must involve the drawing up of an

appropriate pricing policy. This strengthens the importance of gathering support for achieving international agreements, whether they are arrangements involving both producer and consumer countries, producers' associations or other schemes, whose main goal is to establish price stability. Only through a reduction in price instability, short-term and long-term, efforts to foster consumption, to maintain the competitiveness with other substitutes, or to find new end-uses can be sustained. Forward integration into more advanced fabricating processes should also help reduce price instability.

Thirdly, the reiterated importance of R & D on new and traditional uses should be backed by sufficient financial resources. Taking into account the limited finance available for the Third World, it might be beneficial to identify specific research projects which are less ambitious and easier to implement. Obviously, the scope and complexity of R & D activities can be expanded through agreements and co-operation with other producers' governments and international research organizations.

2. Agricultural raw materials vs. their synthetic substitutes

Agricultural raw materials compete with synthetics in terms of price and non-price factors. With respect to the former, while the first oil price hike in 1973-1974 improved the competitive position of natural products temporarily, agricultural raw materials have become less competitive in the early 1980s than in the period preceding the first oil crisis, despite a second oil price rise in 1979-1980 and a sharp decline in commodity prices since 1980. As for the non-price factors, the main ones are uncertainty over supply disruptions, lack of storage facilities and the standard quality and technological advantages of synthetics over natural products in some end-uses. Nevertheless, it is also undeniable that such natural products as those examined below have in recent years maintained or regained their competitive edge thanks to their technical properties.

a) Hides, skins and leather goods

Leather has three major synthetic substitutes, namely polyurethane-coated fabrics, PVC-coated fabrics, and poromerics. Due to leather's unique properties of water retention, air permeability and extendibility, however,

these synthetics, except in footwear soles and in the low-priced open women's footwear sector, have failed to compete significantly with the natural product. The shoe upper market at large has remained almost unaffected by synthetics, owing to leather's superior properties and consumer appeal.^{29/} The share of the footwear sector in total leather supplies may have decreased during the last two decades, owing not so much to synthetics but chiefly to the growing demand for leather clothing and other leather goods. The appeal of high-quality consumer goods, especially in the DMECs, has turned leather from a utilitarian raw material into a fashion and prestige product (FAO 1988, 1987).^{30/}

Admittedly, the price instability in supply and the lack of any close technical substitutes in the main end-uses has led to large fluctuations in leather prices. But the effect of price instability tends to weigh more heavily on non-footwear end-uses (e.g., garments, upholstery and fashion accessories) in which leather as a raw material generally accounts for a higher proportion of total costs. FAO (1987, p.7) concludes that "despite the use of synthetic substitute materials in numerous competing end-products, they have not been a serious threat to leather except in periods when hide prices are excessively high. This situation is likely to prevail for some time to come unless hide prices remain very high for a lengthy period or a technological breakthrough would result in the development of a low-cost material with a close resemblance to the collagen structure of hides and skins, permitting not only the duplication of the wear properties but also the physical appearance of leather".

As it is a commodity of inelastic demand and supply, producers are likely to benefit from an increase in demand resulting from end-use research and promotion, while an increase in supply could bring large gains to consumers. Producers should continue to promote an awareness among end-users about its superior technical properties and to raise the premium which consumers are willing to pay for it over synthetics.

b) Cotton and wool

The man-made competitors of natural apparel fibres fall into two distinct groups: cellulosic fibres (acetate and rayon) and non-cellulosics or true synthetics. In the latter group, there are three main types: polyamides, that

is nylon in its various forms; polyesters; and acrylics. The world consumption of rayon and acetate has been at a standstill while that of synthetics has expanded substantially in the last two decades, as shown by the latter's 37.5% share of the total textile fibre market in 1984, in contrast to 9.7% of rayon and acetate (International Cotton Advisory Committee 1985). Natural fibres, that is, cotton and wool, have accounted roughly for 50% and 5% respectively of world textile fibre consumption. As seen in Table 4, both world and per capita apparel fibre consumption have increased in the 1980s.

Cotton competes with synthetics in basically three broad industrial activities: clothing, household uses and industrial applications. In most industrial and household uses its technical performance is found to be inferior to that of synthetics, and markets have been lost even where fibres lack a cost advantage over cotton. In the remaining household uses and in clothing, cotton competes mainly with polyester, typified by its cost-effectiveness and easy-care properties. But at the same time, the moisture absorbency and appearance of cotton, coupled with improvements to endow it with some easy-care properties, have proved to be important demand factors. As a consequence, the consumers' acceptance of cotton has increased markedly: in the United States cotton represented 40% of all textile fibre retail sales in 1985, excluding the carpet sector, in comparison to 34% in 1975. A particularly impressive performance has been that in the women's clothing sector, in which the share of cotton increased from 16% in 1975 to 30% in 1984. A greater preference for cotton is also noticed in Japan and Western Europe (International Cotton Advisory Committee 1985). The cotton content of cotton/polyester blend also has increased in recent years (FAO 1985).

On balance, cotton has managed to compete successfully in those end-uses where it is "visible" to the final consumer, enjoying a premium over synthetics in the developed world. In developing countries, it continues to meet most of the demand for textile fibres. All these developments, in turn, suggest the need for intensifying market promotion efforts.

Wool has established a much more privileged status than cotton in world textile markets. Though it is blended with polyester in suitings, with nylon in carpeting, and with acrylics in knitwear, pure wool items command a price

Table 4

WORLD APPAREL FIBRE CONSUMPTION
(1000 bales)

	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90
Synthetic fibres <u>a/</u>	62 946	67 102	70 363	72 256	74 752	75 502	-----	-----
Wool <u>b/</u>	7 491	7 611	7 688	7 718	7 893	8 075	-----	-----
Cotton	66 540	68 174	69 965	76 131	83 719	83 068	83 388	86 000
Total consumption	136 978	142 887	148 016	156 104	166 365	166 646	168 000	172 000
Share of cotton	48.5%	47.7%	47.3%	48.8%	50.3%	49.8%	49.6%	50.0%
In total consumption population (1000)	4 602	4 680	4 758	4 838	4 915	5 003	5 090	5 177
Cotton consumption per capita (lbs)	6.94	6.99	7.06	7.55	8.18	7.97	7.86	7.97
Total consumption per capita (lbs)	14.29	14.66	14.93	15.49	16.25	15.99	15.84	15.95

Source: Cited in International Cotton Advisory Committee (1988).

a/ Synthetic fibres production. The calendar -year data are adjusted for harvest years using 5/12 - 7/12. The estimate for 1987/1988 is based on the 1987 production, equivalent to 76.5 million bales.

b/ Estimates are based on the harvest year 5/12 - 7/12. The 1987-1988 estimate is based on a 8.0 million bale figure of 1987.

premium over blends. Campaigns by the International Wool Secretariat to promote the "Woolmark" brandname, have been instrumental for this outcome.

c) Natural rubber

Natural rubber competes with synthetic elastomers on a varying degree depending on the specificity required by each end-use sector. Apart from one synthetic (CIS-1-4 Polyisoprene), which has the same molecular structure and thus technical properties of natural rubber but is considerably more expensive, it competes mainly with styrene-butadiene rubber (SBR). These materials compete in terms of price in a wide range of end-uses where technical specifications are not primary considerations.

The demand for all elastomers --natural or synthetic-- is a derived demand, with approximately 50-60% of them being used in tire production and another 15% in non-tire automotive products, and the remainder in household and industrial sectors, such as footwear, carpet backing, and other industrial and medical applications. Since almost 70% of the world's natural rubber is consumed by the automotive industry, its demand is influenced by the rate of car production and down-sizing. In the last decade and half, the total elastomer market expanded rather slowly, owing to the setbacks experienced after the oil crises and production cuts in the motor industry. The natural rubber's share of the world elastomer market declined slightly, however, thanks to the gains achieved in the tire sector of the DMECs, offsetting losses in non-tire sectors.

The gains in the tire sector are, in turn, attributed mainly to the massive shifts from cross-ply to radial tires and to increases in heavy-duty tire production. In major European countries, radialization of tire is almost complete and in the United States and Japan the process of radialization will soon reach the European level. As the natural rubber content is higher in radials than in cross-ply tires, the continuing process in the United States and Japan as well as in other developed and developing regions will favor natural rubber demand.

In tire-making, natural rubber competes with SBR and polybutadiene rubber (RB), and is liable to substitution by synthetics through relative price changes. Therefore, significant and sustained price increases in natural rubber to levels substantially higher than those of synthetics should lead to

market losses and to the development of cheaper isoprenic rubbers, which would displace natural rubber in the long-run.^{31/} It seems certain that a stable-price strategy would enable it to maintain its share of many end-uses against SBR, and that the highest possible proportion of available supplies should be directed to such end-uses which require the technical characteristics of isoprenic rubber.

d) Jute and sisal

Among agricultural raw materials the most dramatic displacement by synthetics can be found in jute and sisal. Outlets in packing and carpet backing --the principal end-uses for jute-- have diminished owing to an increasing trend toward bulk handling and re-packaging for retail sales and to a progressive weight reduction of carpet backing. The already dwindling market has been overtaken by polypropylene, the single most important synthetic fibre which competes with jute. Over the past decade, polypropylene managed to lower its price both in current and real terms as a result of large investments in production capacity and scale economies and improvements in technology. Thanks to the technical advantages and low prices of polypropylene, the share of jute in primary backing for tufted carpets plummeted from 89% in 1967 to barely 5% in 1983 (World Bank 1986). Serious competition from synthetic products in packaging --bags, sacks, bale wraps etc.-- reduced jute demand in virtually all consuming countries.

The consumption of agricultural twines --the main end-uses for sisal-- recovered in 1985 its 1970 level, but the share of polypropylene, its major competitor, in the total twine market has grown slowly but steadily to the detriment of sisal (FAO 1986 b).

In the light of a depressed petroleum market, which is expected to prevail for some time, polypropylene prices are unlikely to rise substantially in a sustained manner. At the same time, the introduction of a more efficient polymerization technology and the development of plastics industries in areas other than the DMECs, could result in further erosions of packaging markets for jute, while continued improvements in harvesting techniques could lead to more reduced markets for sisal. Further inroads by synthetics might be checked by the development of new outlets and more aggressive promotion policies of the natural products.

e) Policy implications

The foregoing brief examination on the competitiveness of some agricultural raw materials leads to basically two kinds of measures which may be strengthened at the national, regional and international levels: (i) encouragement of demand; and (ii) reduction of investment risk through improvements in price competitiveness.

As for the first one, product differentiation, in order to change the image and taste of natural products for consumers by emphasizing their "natural" characteristics, which are lacking in synthetics, has an important role to play in market promotion. In turn, their inferior technical properties against those of synthetics, should be overcome or improved by R & D. The standardization of materials and use of appropriate brandnames, as in the case of "Woolmark", could help enhance uniformity in quality.

Referring to the second, the competitive position of natural products might be improved through price stabilization. In products with no clear technical advantages over synthetics and thus in need to compete mainly in terms of prices, priority should be assigned to production research. This is aimed at lowering costs and enabling production to be maintained at the price fixed by the synthetic competitor. Price stability of natural products should make input substitution more difficult and prevent to some extent the development of new substitutes. In cases where price competition is small, because of a commodity's intrinsic properties, emphasis should be placed on marketing and promotion programs, coupled with end-use research, in order to expand outlets and to fetch higher prices. In this connexion, the existing regional or international organizations working in these areas should be taken advantage of and be better equipped with sufficient funds.

IV. SOME STRATEGIC AREAS FOR IMPROVEMENT AND CO-OPERATION

1. Technological competitiveness of Latin America in international trade

A fundamental basis for successful, sustained technological innovation to bring about new or improved products, processes or services is that financial and human resources be directed to such purpose. Though it is true that there is no one-to-one correspondence between the level of endowed resources and that of the desired result, countries with large investments in R & D have generally appropriated market opportunities much better than those who did not. An estimate (UNCTAD 1987 e) suggests that in 1983 the world's R & D expenditure reached over \$265 billion, and that of this total the DMECs and the socialist countries of Eastern Europe absorbed \$192 billion and \$64 billion, respectively, leaving a combined total close to \$9 billion to the Third World. In terms of total R & D expenditure as a percentage of GNP, that for the DMECs as a whole in the first half of the 1980s was around 2.4% whereas that corresponding to Latin America stood at 0.5% (UNESCO 1987). This R & D indicator, coupled with others such as the number of scientists and engineers engaged in R & D, professionals and technicians as a percentage of the economically active population, literacy rate and the level of education, however, puts Latin America in a more favored position than Asia and Africa (Teitel 1986, UNCTAD 1987e). Nonetheless, the absolute amount is important from the point of view of the potential capacity to innovate, and in this sense the region is entirely deficient: for instance, the volume of technological resources for Brazil, Argentina and Mexico taken together was similar to that of the United States General Motors (ECLAC/UNIDO 1985). The absolute and relative meagerness of the region's expenditure in R & D efforts implies a need for selectivity.

It then follows that developed countries are and will be increasingly specializing in high-technology production, which requires a high level of human capital and extensive R & D, and that in these high-technology industries they seek to maintain or strengthen international competitiveness in production and trade. Nevertheless, it should also be recognized that in

recent years high-technology-embodied exports by developing countries are becoming an integrated part of international trade (UNCTAD 1987 e).

To define and calculate the technology intensity or content of a product is a complicated task. Allowing for some inherent difficulties and ambiguities it entails, it is still useful to examine, as UNCTAD (1987 e) has done, the basic competitive positions of the region in international trade in accordance with the level of technological sophistication. The criterion adopted for the classification is the relative importance of R & D effort as measured by the ratio of R & D expenditure to production.^{32/} All products are considered at the five SITC (Standardized International Trade Classification) digits. They are classified according to the above-stated R & D intensity into three main categories --high, medium and low technology.^{33/} It is important to point out that most products in the low group and some in the medium group are natural resource-intensive products, with many of them being only roughly processed products, and therefore they may be considered as primary commodities as generally defined.^{34/}

Statistical data on the composition of manufactures imports of the DMECs by R & D intensity category and major region of origin (see Table 5) shed light on the changing competitiveness of developing countries in these markets. The table suggests first that although they still account for a relatively small proportion of total manufactures trade, the products of high R & D intensity industries have tended to be among the relatively more rapidly growing exports for all groups of countries. Also, high and medium R & D intensity industries have been increasing their relative importance in total exports whereas that of the low R & D intensity group has been falling. Although the rate of growth of these exports declined progressively over the period, the deceleration was less pronounced for the developing countries as a whole than for the rest of the world. In 1985 the DMECs accounted for more than three-quarters of the market share for manufactured imports of high and medium industries. In low R & D areas, these countries still maintained a market share close to 60%. What is noticeable, however, is a significant inroad made by developing countries.

Among the developing regions, the market shares of Latin America rose slightly throughout the 15-year period in both the high and medium R & D

Table 5

MANUFACTURES IMPORTS OF DEVELOPED MARKET ECONOMIES BY R & D INTENSITY CATEGORY AND MAJOR REGION OF ORIGIN

Country or region of origin	Market share (per cent)				Value (\$ million)	Annual growth rate (per cent)		
	1970	1975	1980	1985	1985	1970-75	1975-80	1980-85
A. High R & D intensity								
World	100.00	100.00	100.00	100.00	158196	19.7	21.9	5.5
Developed market-economy countries	89.30	86.91	79.86	77.57	122712	19.0	19.9	4.9
Socialist countries of Eastern Europe	.61	.97	1.18	.55	863	31.5	26.7	-9.5
Developing countries	2.89	6.92	9.82	13.20	20887	42.5	30.8	12.0
Latin America	1.02	2.18	2.08	3.36	5315	39.4	20.7	16.2
Africa	.12	.18	.62	.33	525	29.8	56.2	-7.0
Asia	1.49	4.29	6.90	9.31	14721	47.8	34.0	12.1
Oceania	.00	.00	.01	.00	5		47.6	-6.5
B. Medium R & D intensity								
World	100.00	100.00	100.00	100.00	371717	18.4	19.8	3.0
Developed market-economy countries	80.80	81.89	80.89	77.75	288994	18.7	19.6	2.2
Socialist countries of Eastern Europe	1.22	1.54	1.44	1.10	4083	24.1	18.3	-2.4
Developing countries	4.80	5.03	6.72	8.95	33276	19.5	27.0	9.1
Latin America	1.43	1.42	1.57	2.14	7970	18.2	22.3	9.7
Africa	.43	.26	.26	.27	1015	7.3	19.4	4.1
Asia	2.46	2.81	4.42	6.16	22886	21.6	31.2	10.1
Oceania	.30	.34	.23	.10	372	21.3	11.0	-13.0

Table 5 (concl.)

Country or region of origin	Market share (per cent)				Value (\$ million)	Annual growth rate (per cent)		
	1970	1975	1980	1985	1985	1970-75	1975-80	1980-85
C. Low R & D intensity								
World	100.00	100.00	100.00	100.00	380955	19.2	17.0	-0.1
Developed market-economy countries	69.89	67.99	64.77	59.36	226137	18.5	15.9	-1.8
Socialist countries of Eastern Europe	3.66	4.44	4.69	4.48	17053	23.9	18.3	-1.0
Developing countries	15.80	18.83	21.21	25.13	95751	23.5	19.8	3.3
Latin America	6.33	7.01	6.81	6.55	24957	21.6	16.3	-0.9
Africa	1.76	1.68	2.07	2.33	8887	18.2	22.0	2.3
Asia	6.80	9.24	11.48	15.31	58316	26.7	22.2	5.8
Oceania	.18	.26	.17	.13	506	27.9	8.0	-5.3

Source: UNCTAD secretariat calculations based on United Nations Statistical Office trade data (Comtrade). For the methodology of classification into R & D intensity category see UNCTAD Trade and Development Report 1987.

intensive industries. It is important to note that the performance of Latin America, in comparison with Asia ^{35/} during the above period has been much less impressive, in terms of absolute values of trade and their growth, for all three R & D categories. This is a result, on the one side, of Asian countries' efforts to promote high-tech exports especially of electronic components, telecommunication equipment, and non-electrical and electrical machinery, and on the other, their serious efforts to improve their position in low R & D manufactures mainly through the processing of raw materials.

In general, the use of new technologies up to now does not seem to have prevented developing countries --including both the leading NIEs and others-- from increasing the growth of their exports and generally enlarging their shares in total DMECs imports of a large range of manufactures. An outward orientation of the trade policy approach, as practiced in the majority of Asian countries and in some of Latin America, offers dynamic potential benefits for export expansion based primarily on natural resources and low costs of labor. Admittedly, those developing countries with sufficient technological mastery to be able to absorb these innovations will be in a position to maintain or even improve their export shares, while those countries lacking the necessary skills, knowledge basis, institutional flexibility and a basic capital goods industry, are more likely to fall behind. Enhanced export competitiveness requires greater diversification and integration of productive structures, especially development of linkages with input-producing home industries and other input-supplying economic sectors.

2. Processing

The interest in local processing as an economic objective for developing countries arises from a variety of reasons. They include: (i) an increase in the product's value-added; (ii) reduction in export earnings fluctuation; (iii) promotion of economic "linkages" in the national economy; (iv) control over marketing and pricing and the possibility of obtaining monopolistic and resource rents; and (v) as mentioned earlier, the potential for enhanced information about the industry and the market.

The examination of the Latin American trade in commodities reveals a typical structure in which the countries in the region export goods in a primary state and import the same ones from outside the region once they have undergone a manufacturing process. An ECLAC (1986 b) study, which reviews Latin American exports to and from OECD of 20 major commodities at three different processing levels (i.e., primary, semi-processed and processed), confirms this conclusion. The study shows that though in 1984 the value of the regions' exports of the said commodities to OECD was six times higher than that of imports, the majority of commodities were exported with minimum processing. Meanwhile, the region imported the same materials-embodied products of higher transformation.^{36/} It should be stressed that the term, "processed products" still refers to the realm of commodities excluding the subsequent phases of advanced manufacturing and industrial processes.

Over the years the proportion of developing countries' commodity production which is locally processed has increased. Although, the growth rate in the above local processing and in the relative importance of processed imports by the DMECs from developing countries was fairly rapid in the 1960s and 1970s, in a majority of cases it has been slowing down even since. Moreover, recently a significant portion of imports by developed countries of certain processed commodities, such as those based on iron ore, cotton and wood, have originated not from developing countries producing the raw materials but from those importing and processing them, notably the NIEs of Asia. Some statistical estimates (UNCTAD 1987 a c) on the level of processing among different developing regions tend to accord in the view that Latin America as a whole processes a smaller proportion of the same products exported to developed countries than the Asian counterpart.

High processing potentials for the Latin American region can be easily illustrated by looking at its shares in world mineral reserves and world mine and metal production. Table 6 highlights that in spite of being endowed more favorably in mineral reserves and mine production than Asia (in this case includes Japan) in bauxite, copper, lead, zinc and iron ore, the region's share in these products at the refined metal stages are not significantly different or even lower. A most striking case is iron ore in which both reserves and mine production exceed appreciably those of Asia, but raw steel

production is 75% below that of Asia. This low processing of traditional metals is partly due to the fact that the region's share in world consumption for each of the seven metals is substantially lower. Though not shown in the table, the region's participation in semi-manufacture production of these metals is also negligible (see World Bureau of Metal Statistics). The expansion of downstream activities in this sector means, therefore, a strengthening of sectoral policies in favor of local processing, utilizing a series of final demands which will have an intensive and rational use of abundant natural resources. This process should favor the selective expansion of activities which will bring with them sustained technological progress, as well as the generation and adequate incorporation of the so-called high technologies in selective areas.

Taking into account the comparatively sluggish expansion of processing activities and the fact that developed countries continue to be major processors of commodities and producers of semi-manufactures, Latin America should direct more efforts to raise the processing level. Needless to say, however, its extent depends on the technological characteristics of each commodity, capital and skill intensity, transport costs, the ownership structure of the industry, the incidence of protection in the main consuming countries as well as the degree of unexploited production gaps between distinct processing levels. In this context, developing countries would be well advised to keep abreast of technological developments and to undertake feasibility studies in order to determine the sensitivity of the expected returns on proposed projects.

3. Re-orientation of trade in commodities

One potential area of action with the present technological capabilities of Latin America is the inward redirection of its trade. Despite the indication of available studies (ECLAC 1986 c, Sanz Guerrero 1986, INTAL 1986) that the region possesses a high potential for increasing intra-regional trade in commodities, it presently stands at a low level and it has greatly diminished during the 1980s. In 1983-1985, the total intra-regional trade in non-fuel primary commodities stood at an 8% level: the region, during this period,

Table 6

WORLD RESERVES OF MINERALS, MINE AND METAL PRODUCTION
AND METAL CONSUMPTION, BY REGION 1985

Commodity	World	Europe	North <u>a/</u> America	Latin America	Africa	Asia <u>b/</u>	Australia/ Oceania	Central economy countries	Western industrial countries	Developing countries
	(thousands of tons)					(percentage)				
<u>A: World reserves of minerals (1985-1986)</u>										
Bauxite	21 034 000	5	0	28	33	9	21	4	26	70
Copper	337 000	1	22	33	18	5	4	17	26	57
Lead	86 500	12	35	6	6	3	17	21	67	12
Zinc	147 600	15	26	12	8	11	11	14	64	22
Tin	3 240	4	2	8	5	65	6	10	13	77
Iron	65 502 000	4	12	18	5	7	14	40	34	26
Nickel	44 400	7	17	5	7	13	27	24	34	42
<u>B: World mine production</u>										
Bauxite	88 019	8	1	21	18	4	35	13	44	43
Copper	8 436	5	22	23	16	6	5	23	32	45
Lead	3 548	12	20	14	6	4	14	29	50	21
Zinc	6 918	17	20	16	5	7	11	25	53	22
Tin	197	3	--	24	5	45	3	20	8	72
Iron	518 496	6	11	19	7	5	12	40	31	29
Nickel	789	4	23	7	7	10	19	30	42	28
<u>C: World metal production (refined)</u>										
Aluminium	15 430	24	31	8	3	7	7	20	64	16
Copper	9 714	17	20	14	9	13	2	25	49	26
Lead	5 616	29	23	7	3	9	4	25	62	13
Zinc	6 750	29	15	7	3	15	4	27	60	13
Tin	206	13	2	17	3	44	1	20	18	62
Raw steel	714 997	22	13	5	1	20	1	38	51	11
Nickel	767	14	19	6	5	15	10	31	53	16
<u>D: World metal consumption (refined)</u>										
Aluminium	16 253	25	29	5	1	17	2	21	67	12
Copper	9 613	29	22	5	1	18	1	24	65	11
Lead	5 421	30	22	5	2	13	1	27	61	12
Zinc	6 492	26	17	6	2	19	2	28	57	15
Tin	213	26	19	5	1	21	1	27	61	12
Raw steel (1983)	656 331	18	16	3	2	19	1	41	45	14
Nickel	787	28	20	2	1	21	1	27	67	6

Source: Kürsten et. al. (1988)

a/ Includes the United States and Canada.

b/ Includes Japan.

directed more than 62% of commodity exports to the DMECs, while roughly 20% and 10% were absorbed by the socialist countries and the other developing regions, respectively. Asian markets alone absorbed 6% of its commodity exports. Intra-Latin American trade in commodities is believed to be substantially lower in commodities than the corresponding figure for manufactured exports.

It is interesting to observe that the ratio of intra-regional commodity trade is not only at a low level but also of minor importance when compared with other developing regions. During the last two decades Asia managed to increase its intra-regional trade in non-fuel commodities by a substantial margin: from 22.5% (1966-1970) to 27.9% (1975-1979), and to 34.0% (1983-1985). Asia has been able to increase this ratio in a consistent manner in each of the major products categories; that is, food products, agricultural raw materials, and minerals and ores. To a lesser degree, the African region has managed to increase this ratio, also in each of the three categories (UNCTAD 1987 c).

Another ECLAC study (1986 c), which analyzes the trade structure by origin and destination, at a more disaggregated level (SITC 5 digits), points out clearly the magnitude of potential displacement of extra-regional sources by internal origins in the regional commodity trade. As far as food and agricultural raw materials are concerned, the potential for redirecting trade is particularly rich for such products as maize, wheat, sugar, soya beans and its by-products, and other oilseeds and oils. In minerals and metals, the most salient items are aluminium, iron and steel, and copper products. Petroleum and its by-products, with a high feasibility for regional self-sufficiency --regional exports to the rest of the world far exceeding regional imports-- has undoubtedly the highest potential. Using the trade figures of the mid-1980s, the study suggests that intra-regional trade could be considerably expanded, and that efforts to redirect trade in 40 products (at SITC five digits) towards the proper region could increase regional trade in commodities by more than \$15 billion.

There are substantial obstacles to fully benefit from these potentials. Tariffs are one of the major barriers and are usually applied indiscriminately regardless of supply origin. The regional tariff preference (PAR) system

within the framework of ALADI has in many cases an insignificant level and an important number of products are excluded from it. In addition, a series of paratariff measures are applied, in a majority of cases uniformly, with no differentiation in origin. A major non-tariff barrier is known to be transport costs, which clearly favor procurement from outside the region (INTAL 1986). Marketing services and financing, found to be totally deficient in the region, are heavily dependent on the channels of TNCs or developed country governments, with their low propensity to increase regional trade.

Regional co-operation in this direction should be emphasized, when, as is now the case, the region's commodity exports are facing growing protectionism in the markets of developed economies, whose demands for a number of commodities are becoming more saturated. The growth of regional trade is encouraged not only for saving the region's meager external resources and regional food security, but also for taking advantage of the difference in the consumption level between developed and developing regions. It should be stressed that the scope for regional trade should increase substantially when the countries in the region achieve a higher level of commodity processing.

4. Marketing

The importance of marketing capabilities, in relation to copper and aluminium, was emphasized earlier, in order to bring to light the desired role of trading agents to gather/process/disseminate market information. Appropriate and timely decisions on production, marketing and investment require correct understanding not only of local conditions in trading-partner countries but also of international macro-economic indicators (i.e. movements of interest rates, currencies and prices of "financial" assets all of which affect commodity prices). With the development of advanced technologies, particularly the high speed of information processing, leading to a spreading practice of "program trading" and round-the-clock trading among commodity exchanges, commodity markets have become more than ever an integrated part of overall financial operations for international investors. This feature, in turn, implies the need for developing countries to create a market

intelligence infra-structure competent enough to assess the fairness of contract terms, level of prices and profit margins sought by consumers.

Furthermore, the areas of marketing, processing and increases in intra-regional trade are intricately related, since the possibilities for processing before export depend on the ability to secure beforehand market outlets for the processed product. Prior assurance of market possibilities is often a requisite for raising the necessary investment funds.

Levels of intra-regional trade depend also on the regional entities' capacities to replace the trade-related services provided mostly up to now by TNCs. In this view, the strengthening of the existing trading entities (national or regional) and/or the creation of new ones, with a much more consolidated information- and financial-base seems an urgent necessity.

Notes

1/ It is important to note that the factors which seem to have gained importance in recent years did not escape the critical eyes of Prebisch (1951) and H.W. Singer (1950 b). As early as 35 years ago, they pointed out a possible decline in demand for commodities, due to technological changes leading to a reduction in the raw material intensity of certain production processes, and to competition from synthetics and substitutes.

2/ Most well-known but at varying stages of development and diffusion, are numerically controlled machine tools (NCMTs), industrial robots, computer-aided design and computer-aided manufacturing (CAD/CAM) and flexible manufacturing systems.

3/ A process known as "bacterial leaching" using bacteria to recover minerals cheaply from low grade ores, could benefit developing countries with few resources to invest in costly metallurgical industries. Selected strains of bacteria are used to accelerate the leaching process which consists of the extraction of soluble metallic compounds from ores, usually dissolving in sulfuric acid. Though industrial-scale applications are still limited, projects at various stages of advancement exist, involving several Andean Region countries (Warhurst 1985).

4/ It seems certain that modern materials science is currently undergoing a profound structural transformation. In contrast to the earlier periods when material needs were met by adapting existing natural substances, now entirely new synthetic materials are created by rebuilding their molecular structures. Materials science of today is increasingly characterized, then, by three features which distinguish it from the past: (i) emergence of new materials being developed at a more rapid pace, resulting in a correspondingly

accelerated substitution process; (ii) creation of new materials, manipulating at the molecular level, for specific properties and uses rather than modifying existing materials, with a result that manufacturing processes are charged to accommodate the new material itself; and (iii) requirement of a much wider range of expertise and scientific knowledge, which in turn makes it indispensable for materials scientists, design engineers and production line specialists to work together to reduce total production costs (Balazik and Klein, 1987).

5/ From an expert's view, a single technological breakthrough alone is not sufficient to achieve progress in high technology. Rather, only through the organic fusing of several technological breakthroughs in a number of different fields, a new technology can be created and appropriately exploited. He cites, as exemplifying cases in Japan, the emergence of mechatronics in 1975 through reciprocal research investment in the four fields of ordinary machinery, precision instruments, electrical machinery and communications/electronics; appearance of biotechnology in 1974 through reciprocal investments between the fields of food, pharmaceuticals and industrial chemicals; and the appearance of new ceramics in 1982 through investments across the fields of ceramics, ordinary machinery and electrical machinery (Kodama 1988).

6/ There has been an increasing trend towards greater integration of geological, geochemical, geophysical and remote sensing techniques, which have largely, but not entirely, supplanted the traditional approach of the individual prospector.

7/ Demand for iron ore directly for steelmaking is relatively small (around 2% of iron ore demand), for the main feed are the primary metals (pig iron, generally as liquid hot metal, scrap and sponge iron). However, a certain quantity of iron ore, mainly in the form of lumps and pellets, is directly fed into steel-making furnaces. The amount may vary significantly, depending upon the differences in furnaces types, in particular between oxygen converters and open hearth furnaces.

8/ The assessment of the Green Revolution for developing countries evolved around not only the purely technological but also socio-economic dimensions. Critics have argued that the strategy along the line of the Green Revolution has exacerbated class inequality, premature rural migration and urbanization as a result of inappropriate factor utilizations.

9/ According to UNIDO, there exists a wide North-South gap in biotechnological investigation capacity. Recent surveys of companies involved in biotechnology, show that only 20 out of a world total of 1 036 companies are in the Third World. A characteristic trend in recent years has been the acquisition of a large number of seed companies by transnational firms, particularly pharmaceutical and petrochemical companies. Because biotechnology involves the ability to link new varieties of seed to the use of specific fertilizers and pesticides, supply of such seeds are claimed to enable the transnationals to expand a market for other agricultural inputs. A lop-sided research capacity is also reflected in Ahmed's affirmation (1988)

that there has been an outflow of genetic resources from the "gene-rich" South to the "gene-poor" North. It is estimated that 90% of all germplasm (total genetic variety available to a species) came from the Third World, due to that the temperate zones lost almost all of their phylogenetic resources under the weight of the glaciers. Some 40% of that germplasm ended up in the gene banks of Europe and North America, while another 40% was stored by the International Agricultural Research Centers (IARCs). Only 15% was stored directly in the gene banks of developing countries.

10/ Auty (1985), however, cautions that the demand for materials and the growth in services do not have to be in an inverse relation: the growth in services, consisting of government expenditures on constructions of schools, highways, defense and energy R & D, may be relatively resource consuming rather than resource conserving.

11/ It can be observed that high-tech applications are accounting for growing shares in the United States patterns of metals end-use demand: for example, in the case of electronic components (silicon metal, beryllium, tantalum); industrial ceramics (titanium, zirconium, antimony); special chemical uses (cobalt, nickel, molybdenum, vanadium, titanium, zirconium); and special machinery and tools (chromium, tungsten, vanadium, titanium, zirconium).

12/ A most remarkable product replacing traditional non-fuel materials is plastics. On a volume basis United States consumption of plastics now exceeds that of steel, copper and aluminium combined. It is ascertained that at least one-fourth of all plastics and resins produced in this country displace non-fuel mineral materials. Polymer materials already have replaced about 7% to 9% of the steel consumed in domestic motor vehicle production, and may displace more than double that amount by the year 2000. In the construction industry, it is estimated that polymers have replaced slightly less than 10% of the steel consumed, and by the year 2000 could displace as much as 13%. In aerospace applications, polymer composites are displacing aluminium used for the "skin" of many new military aircraft, and are expected to make large inroads in passenger airplane manufacturing during the next decade (Fraser et. al. 1987).

13/ For a detailed analysis on this issue, consult Tilton (1983).

14/ Even when the technology for substitution exists, the need to re-equip the plant or to build new facilities, with possible personnel retraining, usually postpone producers' decision to switch until they become certain that the change in prices is not temporary. The expense of altering the production method is warranted if the threshold price at which substitution occurs is higher for a reasonable period of time, and once a change is made, the price of the replaced material must fall appreciably below the original level before producers decide to re-switch.

15/ As an example, the major advantage of aluminium over copper in the stringing of overhead power cables is the former's lighter weight, thus requiring a fewer number of support towers per unit length than would be

needed in the case of copper (Dresher 1986 a). Therefore, in this application, the relative cost of the materials have a secondary importance to the economy realized in the installed system. A similar example is found in the beverage packaging industry: the cost of producing an aluminium two-piece beverage container is substantially higher than that for a tinplate counterpart, but aluminium cans weigh less than half of tinplate cans, putting the former in a much more favored position with respect to transport costs. In addition, aluminium cans do not rust or distort the taste of beverages, as tinplate cans are alleged to do, and they are easier and cheaper to recycle (Delmer 1983).

16/ Developing countries' advantage, based on conventional technology, could be in danger of being offset in a wide range of exports including fibres, textiles, apparel, shoes and leather articles, and electric and electronic machinery and components. One of the most striking examples is in the automation of garment manufacturing, whose production process was earlier characterized by separate and skilled labor operations but which is now moving towards computer-aided and electronically-based techniques for grading, laying out, cutting and even sewing functions. See, for example UNCTC (1987).

17/ But this hypothesis is not totally convincing, considering that technological innovation, to some degree, permits affected firms in the DMECs to recover their international competitiveness. The significant reductions in production costs by the American copper companies have shown that a comparative advantage based on resource endowments could be relegated to a second place by other technical and managerial advantages. As Crowson (1988, p.18) argues, "the United States' (copper) industry has been rejuvenated after having stared its possible extinction in the face. Changes in technology, a revitalized management, and favorable shifts in exchange rates came to the United States' rescue".

18/ Due to combined shifts, it is possible for consumption to increase at the same time that intensity of use decreases if there is strong growth in the material-using industries; i.e., less material per unit but more units produced, and as a result, increased metal consumption. A United States study (United States Bureau of Mines, 1986 a) states that this phenomenon, however, has not been observed in the 12 major metals covered for this country for the period of 1972-82, but asserts that it is plausible.

19/ For the 1980 dollar GDP figures of the OECD and Latin American countries, see OECD (1987) and ECLAC (various issues) respectively. Consumption figures are taken from UN, Energy Statistics Yearbook, (various issues), Statistical Yearbook, (various issues), World Bureau of Metal Statistics, World Metal Statistical Yearbook (various issues) and United States Bureau of Mines (1986 b).

20/ In Japan, the largest five steel mills have launched a program to reduce by 1990 their combined capacity from 150 million to 90 million tons, to lower the workforce by at least 25%, and to diversify into coal-based chemicals, computer software, silicon wafer manufacture and special metals using their in-house expertise.

21/ Some experts predict that the displacement of the copper market by optical fibres in the six DMECs (United States, UK, FRG, France, Italy and Japan) of about 230,000 tons by 1990 and a little over 300,000 tons by 1995, is equivalent to 4.3% and 5.6%, respectively, of total copper consumption that would have been projected for these countries for those two dates, assuming no technological "leap-frogging" in fibre optics (Takeuchi et. al. 1986).

22/ In support for a more resilient strength of traditional metals against new substitutes, Duncan (1988) understands that the decline of metals in the DMECs for the 1974-1985 period was largely cyclical rather than a reflection of a new downward trend in the rate of change in metal-saving technology or a change in output mix. The decline resulted mainly from a low economic growth rate and the impact of high energy prices. According to this view, the recent upsurge of capital investment in the DMECs and depressed energy prices which are likely to remain so for some time might revert some of this damping effect on materials demand.

23/ For example, Japan, FRG, and Belgium are all significant net exporters of copper semifabricates, and consumption of wrought copper in these countries is accordingly lower than the recorded consumption of unwrought copper. By contrast, United States consumption of semis and wrought copper, a net importer of these products, is underestimated.

24/ The government decree to use only aluminium in electricity transmission and housewiring increased the use-intensity of aluminium and decreased that of copper as from the late 1960s.

25/ The rate of increase in aluminium consumption is expected to have slowed down to about 4% a year in the 1980s, as the rate of introduction of aluminium in many new end-uses is expected to slow down, while recycling increases in importance, and new substitutes with low energy consumption in manufacturing, such as ceramic materials and plastics, are introduced.

26/ Most bauxite is traded intra-firm and the remainder is sold under long-term contracts, with only small amounts left for the spot market. Similarly, in alumina, only 26-30% is traded outside integrated company systems and only 5-8% in the spot market (Metal Bulletin 1986 p.1).

27/ The budget of these centers is thought to be in the neighborhood of \$6 million a year of which CIPEC contributes approximately 30% (CIPEC 1984). By contrast, ALCOA's 1986 research budget was \$142 million and it is expected to double before the end of the decade.

28/ Interestingly, the most important price was the ALCAN international price, used as a benchmark price for other major and smaller producers. In addition, most major producers were and still willing to enter into short-term fixed priced contracts for the supply of aluminium to consumers. This producers' price system remained in force until late 1978 when trading in aluminium metal began on the London Metal Exchange, followed subsequently by the New York Commodity Exchange (COMEX). The introduction of "exchange" prices and a gradual acceptance of this instrument led to the result that in 1984 the

quotations at the exchanges replaced the role of the producers' price, as of ALCAN, which for a long period of time was considered as the market price of aluminium.

29/ Poromerics, developed in the 1960s and claimed to have a high permeability, could not challenge the privileged position of leather as the price footwear upper material. They have been withdrawn from the market in the industrialized countries, due to their cost ineffectiveness and inferior properties.

30/ With rising income and urbanization, the developing countries' share in leather shoe consumption rose from 22% in 1961-1965 to almost one-third in 1983-1985. However, there are still considerable differences in per capita consumption among regions. Overall annual per capita consumption in developing countries, during the 1983-1985 period, was 0.3 pairs, the figure for Latin America being 0.9. Among the developed countries, while North America and Western Europe have reached a saturation point around 2.0-2.4 pairs per head annually, apparent consumption has continued to rise in Eastern Europe beyond 2.5 level (FAO 1986 a). Rapid population growth will ensure a steady increase in the demand for shoes of 4% per annum in developing countries and further development of the industry is likely to focus mainly on supplying these markets. Exports of shoes from developing countries will continue to be successful in the high-volume, low-cost market, but few of them may compete successfully in the fashion market.

31/ This is particularly important when high concentration of the synthetic rubber industry is taken into account: the petrochemical industry holds more than 50% of the existing synthetics rubber production capacity, whereas tire manufacturers own 40% of total capacity (World Bank 1986).

32/ Obviously, there are certain limitations to a measure of this kind. A list of such products will change over time as new products are developed and as the production technologies of existing products become more widely disseminated and standardized. Moreover, this measure does not fully measure the technology content of the products manufactured by an industry, since industries may differ in their degree to which they rely on their own R & D efforts, as distinct from utilizing technology from other industries or imported from abroad.

33/ High R & D intensity industries are aerospace, office machines and computers, electronics and components, drugs, instruments and electrical machinery. Medium R & D intensity industries include automobiles, chemicals, other manufacturing industries, non-electrical machinery, rubber and plastics and non-ferrous metals. Low R & D intensity industries are stone, clay and glass, food and beverages and tobacco, shipbuilding, petroleum refineries, ferrous metals, fabricated metal products, paper and printing, wood, cork and furniture, and textiles, footwear and leather.

34/ Total non-fuel commodities, composed of agricultural and mineral products, defined as SITC section 0, 1, 2 (excluding 233, 244, 266, 267) section 4, division 68 and items 522-56.

35/ Asia consists of South and South-East, East Asia and Middle East. Latin America includes the countries in the Caribbean.

36/ In agricultural products, the processing level shares of the region's exports to OECD were as follows: primary, 64%; semi-processed, 16%; and processed, 20%. The respective percentages for the OECD commodity exports were 41%, 31% and 28%. There was a large amount of semi- and processed products imported from OECD, but the regional imports of raw commodities were important as well. In the sector of minerals and metals, the situation was more evident: only 22% of the regional exports consisted of processed products, whereas 77% of the imports from OECD involved processed products.

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